Storia della medicina

Collana fondata da Roberto Marcucci e Fabio Zampieri

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Fabrizio Baldassarri, Fabio Zampieri

SCIENTIAE IN THE HISTORY OF MEDICINE

«L'ERMA» di BRETSCHNEIDER
Roma - Bristol, CT

Scientiae in the History of Medicine

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Cover:
Historical plaque of the University of Padua with the motto "Universa Universis Patavina Libertas", located at the Aula Magna in Palazzo del Bo, Padova. Courtesy of Università degli Studi di Padova.

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Scientiae in the History of Medicine: «L'ERMA» di BRETSCHNEIDER, (edd.) 2021; pp. 336; cm. 16,5x23,8 - (Storia della medicina)

ISBN 978-88-913-2018-6 (paper)
ISBN 978-88-913-2021-6 (PDF)

CDD 610.9
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Foreword

Scientiae in the History of Medicine is much more than just a collection of re-worked conference proceedings; it is a step forward in the generation of a new kind of historiography of early modern medicine. Goodbye to old personality-centred stories, dangerously akin to early modern antiquarian compilations; welcome to texts-in-context arguments based on research which mimicks early modern practices of connecting textual and empirical knowledge. This book stems from the *Scientiae* conference that took place at the University of Padua in Spring 2017. *Scientiae* is an international research group at the nexus of early modern studies with the history and philosophy of science. We believe in today's unwaning relevance of early modern knowledge practices even though, by definition, past innovators worked in fields which were distant from later applications: think of astrology in relation to astronomy, or alchemy in relation to medicine, for example. *Scientiae* historiography aims at getting back behind modern ideas of knowing while, at the same time, investigating the early modern antecedents of ideas in the discrete disciplines in which theyhave occurred.

Scientiae in the History of Medicine presents a number of case studies about different, yet inter-twined ways of knowing nature in the early modern period. Be it the medicinal properties of plants or the functions of the human body, ending with a thought-provoking essay on taxonomy, this collection of essays will not cease to stir counterintuitive thinking about both early modern medical practices and our understanding of old world views.

As Convenor and past President of *Scientiae* we cannot but commend yet another successful outcome of our scholarly community's efforts. We thank Fabio Zampieri and Fabrizio Baldassarri for making *Scientiae* in the History of Medicine into such an enganging work which we believe fellow scholars will not fail to appreciate fully.

Giovanni Silvano
Convenor, Scientiae Padua 2017,
Director of CISM-University of Padua

Vittoria Feola
President, of Scientiae, 2017-2020

Notes on Contributors

Fabrizio Baldassarri, PhD, is postdoc at Bucharest University with a project on "The Overlooked History of Vegetal Life", and was postdoc at HAB in Wolfenbüttel and recipient of the Kristeller-Popkin fellowship of the JHP. He has taught medical humanities at the University of Padua. He organized conferences such as "Manipulating Flora", "Vegetative Powers", and "Lights&Shadows in Cartesian Medicine". He has published in *Historia Philosophica*, *Early Science and Medicine*, the *British Journal for the History of Science*, and *Perspectives on Science*. Starting in 2021, he has a Marie Skłodowska Curie fellowship at Ca' Foscari Venice and Indiana University Bloomington.

Roberta Ballestriero obtained her European PhD from the Complutense University of Madrid. She has lectured in Art History for a number of British Universities since 2004 and she is Art Historian in residence at the Gordon Museum of Pathology, London. Currently she teaches at the University of the Arts, London and at the Academy of Fine Arts of Venice. Her research concerns art and science and she spent the last 25 years studying the art of ceroplastics and the 'body of wax'. She was the founder and president of the first International Congresses of Wax Modelling in forty years, and she edited the volumes *Ceroplastics, The art of wax"* (2019) and *Ceroplastics, The science of wax* (2021).

Alessandra Celati has recently concluded a Marie Curie Global Fellowship between Stanford University and the University of Verona, where she is currently research affiliate. Her research focuses on the relationship between medicine and heresy in sixteenth-century Italy, which she examines through an interdisciplinary approach, spanning from the history of ideas, history of medicine and religious history, and innovative historiographical approaches, methodologies, and digital humanities.

She is currently working on a monograph on physicians and heresy in sixteenth century Italy, in particular on the heterodox Italian doctor Girolamo Donzellini. She has published in *Early Science and Medicine* and *Rivista Storica Italiana*. She is the founder and international coordinator of the research group DEaMoNs, Digital Early Modern Networks.

Manuel De Carli is a Research associate at the CESR of the University of Tours (France). In 2019, he obtained his PhD at the Universities of Tours and Roma Tre (Italy), defending a thesis on the history of science, dedicated to tarantism and occult qualities in the work of the Dutch experimental philosopher Wolferd Senguerd. His articles examine tarantism, Aristotelianism and occult qualities. He edits *Meravigliosi ragni danzanti. Interpretazioni del tarantismo nel Seicento* (2020).

Florike Egmond is is a Dutch historian living in Rome. Since 2004 she has worked at Leiden University as a researcher in projects on the early modern natural sciences. She publishes widely in the field of early modern natural history and its overlaps with the history of collecting, medicine, science and communication. One of her special interests concerns the visual history of science, the circulation of visual knowledge, and the role of coloured drawings in scientific communication. Her publications include: *Eye for Detail. Drawings of plants and animals between art and science, 1500-1630* (2017); and *The World of Carolus Clusius. Natural History in the Making, 1550-1610* (2010); and the Gessner-Platter animal drawings: *Conrad Gessners Thierbuch. Die Originalzeichnungen* (2018).

Pierdaniele Giaretta, former full professor of Logic and Philosophy of science at the University of Padua, was president of the Italian Society of Analytical Philosophy (SIFA) and director of the Interdepartmental Research Center in History and Philosophy of Science (CISFIS) of the University of Padua. His main scientific production concerns the analysis of some logical and epistemic paradoxes, formal ontology, reasoning and cognition, and, within the philosophy of medicine, clinical diagnostic processes and the concepts of health and disease.

Maria Kavvadia holds a PhD diploma from the Department of History and Civilization of the European University Institute (Florence, Italy) and an M.Phil Diploma from the Department of History of Trinity College Dublin (Dublin, Ireland). Her research interests mainly focus on early modern scientific cultures, spaces and traditions of knowledge, social-cultural practices in science and medicine, court medicine, pictorial practices and scientific knowledge, body culture and practices in the early modern period. She is author of "The Moresca Dance in Counter-Reformation Rome: Court Medicine and the Moderation of Exceptional Bodies", in *Exceptional Bodies in Early Modern Culture. Concepts of Monstrosity before the Advent of the Normal*, ed. by M. Bondestam (2020).

Cynthia Klestinec, Professor, completed her PHD at the University of Chicago and currently teaches at Miami University, Ohio. Her research focuses on the history of science, the history of medicine and early modern Italy with new work on the history of professions, death and dying, and the role of physicians in end of life care. Her publications include *Theaters of Anatomy: Students, Teachers, and Traditions of Dissection* (2011); with Gideon Manning, *Professors, Physicians and Practices in the History of Medicine: Essays in Honor of Nancy Siraisi* (2017); and with Gabriele Matino, *Art, Faith and Medicine in Tintoretto's Venice* (2018). The latter accompanied her co-curated exhibition at the Scuola grande di San Marco, Venice, September 2018 to January 2019.

Elisabeth Moreau is a FNRS Postdoctoral Researcher at ULB – Université libre de Bruxelles (Belgium). Trained in History and Philosophy of Science, she works on medicine, alchemy and natural philosophy in late Renaissance Europe. She started her postdoctoral research in 2019 as a BAEF Hoover Fellow at Princeton University, for her project on the body's assimilation of food and drugs in early modern alchemy and matter theories.

R. Allen Shotwell is a Professor of Liberal Arts and Director for the Center of Humanities and Medicine at Ivy Tech Community College in Terre Haute, IN USA. Originally trained in physics and applied optics, he holds a PhD in the History and Philosophy of Science from Indiana University. His research and publications focus on anatomy and medicine in the fifteenth and sixteenth centuries. He has published in the *Journal of the History of Biology* and the *Journal of the History of Medicine and Allied Sciences*, and contributed in volumes on Galen in the Renaissance and the corpses in early modern medicine.

Luca Tonetti is currently a Research Fellow in History of Science at the University of Bologna. He received his PhD in History of Science from Sapienza University of Rome, with a thesis on Giorgio Baglivi and his reform of medical practice in *De praxi medica* (1696). He has since held a postdoctoral fellowship at the Centre d'études supérieures de la Renaissance (CESR), University of Tours, and at the Herzog August Bibliothek, Wolfenbüttel. Since 2017 he is Assistant Managing Editor of *Nuncius. Journal of the Material and Visual History of Science* (Brill).

Fabio Zampieri is professor of History of Medicine at Padua University Medical School, Italy. He teaches human sciences, history of medicine, and bioethics to medicine students. His fields of research ranges from the history of prehistoric medicine to contemporary biomedical sciences. He is particularly interested in the history of cardiology, in the history of pathology and in the Darwin's impact on medical sciences. He is a renowned expert on the figure of Giovanni Battista Morgagni and on the history of Evolutionary Medicine.

Alberto Zanatta is curator of the Morgagni Museum of Pathological Anatomy of the University of Padua, Italy. His fields of interest are anthropology, paleopathology and history of medicine, in particular medical museology. He made important contributions in the paleopathological study of the remains of historical figures like Giovanni Battista Morgagni and Gaspare Pacchierotti, with the use of molecular pathology techniques. He teaches history of medicine to medical students.

Fabrizio Baldassarri & Fabio Zampieri

SCIENTIAE IN THE HISTORY OF MEDICINE: AN INTRODUCTION

In its history, medicine has undergone transformations through a combination of various, intersecting disciplines of knowledge, what early modern scholars called *scientiae*. Indeed, the early modern time appears to be one of the most thriving moments, and is probably the perfect period for exploring the active presence of these diverse disciplines at work. Since the sixteenth century, physicians benefitted from the creation of anatomical theaters as locations for the study of anatomy and for inspecting the human body more directly. At the same time, botanical gardens were built at universities as repositories of vegetal bodies (both medicinal and general plants) to be observed, studied, accommodated, and cultivated, while the construction of medical museums helped in shaping the discipline and favoured scholars in observing corpses and diseases, besides the mere instruction of non-experts. For example, the museums of anatomo-pathology at the University of Padua collects a case of the congenital condition *situs inversus*, that is, the reversed arrangement of visceral organs, making this peculiar case visible to scholars and learned people. In this sense, these locations represent both a historical venue, where one could explore the history of medical disciplines, and a place for current study and research. Understanding their construction and uses in the early modern time appears thus crucial to comprehending the boundless condition of medical knowledge and its changes and transformations at the beginning of the scientific revolution.

Constructing new spaces to conduct research, anatomize, and perform observations and experiments helped scholars to ground modern medical knowledge, as locations such as anatomical theaters, botanical gardens, and museums favoured a new approach to medicine. This volume pays particular attention to the University of Padua, a special seat for

DOI 10.48255/M.9788891320186.01

medical knowledge in the early modern time, and the location of important changes in medical *scientia*. Its renowned Medical School was a crossroad of cultures, and accommodated scholars of different nationalities, such as Andreas Vesalius or William Harvey, just to name two physicians whose work has surpassed the boundary of the medical field. Additionally, the University of Padua was one of the first to build important locations, such as an anatomical theater, a botanical garden, and medical museums, as is explored in this volume. Moving from the history of the Medical School of Padua, the volume then aims to uncover the disciplines operating in medical knowledge in different cases and contexts. In the first section, the authors deal with the locations where medicine was operative since the early modern time, especially revealing how much these venues and the disciplines interconnected to them helped shape medicine as a modern *scientia*.

In this sense, in Chapter 2 Fabio Zampieri discusses the Medical School of Padua from its beginnings, especially shaping the interconnections and contexts that grounded the medical revolution of the sixteenth and seventeenth centuries. In Chapter 3, Cynthia Klestinec discusses anatomical theaters and their powers, statutes, and protocols to regulate and control the study of anatomy. By means of these regulations and hierarchies, performances in anatomical theaters grounded medicine as a modern discipline of knowledge. In Chapter 4, Florike Egmond presents a survey of University botanical gardens that shaped medical knowledge, especially focusing on Lorenz Gryll's peregrination across Europe, whose purpose consisted of improving professional knowledge about university gardens in a medical and botanical context. This excursion ultimately reveals the multifunctional organization of university gardens that went beyond mere medical teaching and ultimately shaped early modern culture. In Chapter 5, Alberto Zanatta investigates the birth of the medical museum, especially dealing with the anatomo-pathology museum at the University of Padua. Zanatta claims that the first act was the collecting effort by Antonio Vallisneri, triggered by a philosophical curiosity that significantly differed from the curiosity of the *cabinet de curiosité*. Later endorsed by Giovanni Battista Morgagni, this collecting project was brought to a successful conclusion during the nineteenth century. And in Chapter 6, Roberta Ballestriero presents the case of the Gordon Museum of Pathology in London. While Ballestriero deals with the historical collections at the museum, where one of the first British anatomical ceroplastic artists worked in the nineteenth century, she especially focuses on a less explored issue concerning the legacy of human remains as it affects museums of pathology. The chapter meaningfully deals with (a.) the changes ethical norms have undergone in recent decades in storing and exhibiting human remains, revealing a new moral attitude towards the manipulation of ancient skeletons, (b.) the legal approach to the dead as a way to restore individual rights, and (c.) the educational value of collections, and especially the case of wax reproductions. Attention to the history of medical knowledge acquires particular significance nowadays, as both a way to fight back at the surge of anti-vax movements and studying emerging diseases such as Covid-19.

In the second section of the volume, the authors discuss some more specific case-studies, dealing with relevant figures of early modern medicine, meaningful texts, experimentation, and ultimately highlighting the aspects that shaped medicine as a modern discipline of knowledge. In Chapter 7, R. Allen Shotwell presents the anatomical injections of Berengario da Carpi as a case of medical knowledge combining practice and theory. In contextualizing practices that predate anatomical injections by nearly a century, the author shows the importance of anatomical texts, the theoretical knowledge of physicians, and the practical experience of surgeons, which Berengario resumed in his work. In Chapter 8, Maria Kavvadia explores the sources of court medicine in Papal Rome, especially dealing with Girolamo Mercuriale's *De arte gymnastica*, an innovative angle to understanding the body. This text combines philological, historical and antiquarian erudition with medical and anatomical knowledge, especially recovering Greco-Roman gymnastics. At the same time, Kavvadia importantly depicts the medical pluralism (of university-trained physicians, empirics and other medical practitioners) in Renaissance Rome as a crucial milieu of knowledge that sheds light on medicine as a modern *scientia*. A different *milieu* is discussed in Chatper 9 by Alessandra Celati, who presents a text by Girolamo Donzellini on the Venetian plague of 1575 (and also provides an English translation of it). During the pestilence, Donzellini was serving a life sentence in prison, imposed by the Inquisition as a consequence of the repression of the Protestant Reformation. Yet, in prison, Donzellini engaged in important medical activity and authored a treatise on the plague, ultimately providing a good case-study to frame the rise of medicine as a *scientia*. In the line of curing plagues, in Chapter 10, Elisabeth Moreau discusses the case of Jean Fernel and pestilence. Different from the case of Donzellini, Moreau highlights how much Fernel tried to explain the origin and na-

ture of new contagious diseases, combining both Platonic views on medicine, that is, philosophical treatments of disease and the role of cosmological medicie, with a Galenic approach to pharmacology. In the end, Fernel followed both Galen and astrological, occult factors in providing an explanation of pathologies. In Chapter 11, Fabrizio Baldassarri presents the medical sources and collaborations that illuminated René Descartes' knowledge of medicine, especially highlighting the presence of the Medical School of Padua in medical studies in early modern Holland. Besides the theoretical framework of his philosophy, Descartes' medicine emerged from a combination of personal reflections, anatomical observations, collaborations, and the medical enthusiasm that characterized Dutch culture. In Chapter 12, Luca Tonetti discusses the experiments with drugs in Giorgio Baglivi's *De usu et abusu on vesicantium*. Despite the severe side effects in the medical use of vesicant, Baglivi conceived them as useful under specific conditions, whose efficacy was tested by means of infusory surgery and through the collecting of data. Ultimately, this case reveals how far Baglivi worked in defining a precise systematization for medical experimentation, a crucial aspect of early modern medicine. In Chapter 13, Manuel De Carli traces the presence of Wolfred Senguerd's medicine and philosophy in the study of tarantism at Leiden University in the second half of the seventeenth century. While combining diverse disciplines, such as natural history, physics, and medicine, and dealing with a wide array of sources (from Kircher to Baglivi), Senguerd challenged the difficulties of tarantism, ultimately analysing its occult qualities, but also describing the anatomy, and properties, of spiders. In Chapter 14, Pierdaniele Giaretta classifies diseases from an epistemological perspective, revealing the multiplicity of possible classifications, and the different theories we have at our disposal for different classes of diseases, ultimately specifying the complexity of medical disciplines insofar as no clearly preferable way of classifying diseases emerges.

Originally intended as a development of the presentations on the history of medicine given at the Botanical Garden of Padua on the occasion of the *Scientiae*2017 conference, this volume includes the re-elaboration of a few of those papers, together with some relevant additions from scholars who happily joined, and readily contributed to the project at a later moment. We would like to thank the organizing committee of *Scientiae. Discipline of Knowing*, held at Padua in 2017, whose presentation

forms the foreword to this volume. Without the important chance of meeting, we would have been unable to produce this volume, today. It is to be noted that, while the covid-situation makes online conferences the only viable possibility for the moment, holding conferences and seminars in person is important as we are able to gather together, and allow the discussion of new issues and lay down new projects during various breaks. Indeed, the volume we have put together profited from the rich presentations, and the lovely encounters and productive discussions we had at that time, and then from the later discussions we had with authors. We would like to thank all the authors for their work and their patience. An important support for the elaboration of the volume has been provided by the Romanian National Authority for Scientific Research and Innovation (CNCS – UEFISCDI), project number PN-III-P1-1.1-PD-2016-1496, "The Overlooked History of Vegetal Life. From the Vegetative Soul to Metabolism in Early Modern Philosophy and Biomedicine".

Finally, a special thanks goes to my parents, Rita and Fiorenzo, whose unshakable support and encouragement throughout the years has been crucial for Fabrizio Baldassarri.

July 2020

Fabrizio Baldassarri & Fabio Zampieri

Section 1 – Grounding *Scientia*: The Locations of Medical Knowledge in the Early Modern Period, and Beyond

Fabio Zampieri[*]

THE UNIVERSITY OF PADUA MEDICAL SCHOOL FROM THE ORIGINS TO THE EARLY MODERN TIME: A HISTORICAL OVERVIEW

Introduction

The history of Padua University Medical School covers almost eight centuries and it is related to an extraordinary series of scientists from all over Europe who gave fundamental contributions to the advancement in the understanding of human anatomy, physiology, and pathology, and in the cure of human diseases. However, its "golden age" probably coincides with the Renaissance thanks to its "anatomical school" which saw an uninterrupted sequence of scientists who paved the way of modern medicine thanks to their achievements. Even limiting this historical sketch to that period, it was necessary to make specific choices for focusing our attention to some moments and figures which we consider particularly significant. First, we have decided to delineate some of the crucial cultural characteristics of the "free commune" of Padua. We believe, for instance, that the pre-humanistic movement which born already in the 13th century might be fundamental for understanding the following development of the University. Then, we have focused our attention on two of the most famous figures of the Padua medical school, namely Andreas Vesalius and Hieronymus Fabricius ab Acquapendente. About Vesalius, we have tried to highlight his humanistic culture, perfectly in line with Padua environment, and his revolution based on a new conception of anatomy as the queen of natural sciences. About Fabricius, we have highlighted his new philosophical approach in anatomical studies, based on the study of Aristotle, as well as his new use of anatomical illustrations, giving also a brief description of how his achieve-

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DOI 10.48255/M.9788891320186.02

ments were fundamental for William Harvey's discovery of blood circulation. With that latter discovery, we might support that ancient science definitively declined, opening the way to modern medicine based on the anatomo-physiology of man for understanding and curing human disease. The 18th century was probably the last step for the beginning of this new epoch, thanks to the work of Giovanni Battista Morgagni and his foundation of organ pathology, but this story belongs to a period out of the limits of this paper.

Socio-cultural characteristics of Padua during the middle age

The role of the University of Padua Medical School during the Renaissance as "*the most famous gymnasium in the world*" is rooted in the socio-cultural patrimony of the thirteenth century.[1]

One of the richest and influential cities of the Roman Empire,[2] Padua returned to be a central cultural and economic area from the 13th century. Aristocratic families returned in the town from the countryside, accepting to follow the civil rules. In that period, the city became a *free commune*, that is, a laic and self-governed community organized around professional corporations, independent both from the Bishop, representing the religious power, and from the Emperor of the *Holy Roman Empire of the German Nation*. The city of Padua was among the main protagonists of the Lombard League[3] and of the famous Battle of Legnano on 29 May 1176, when the army of Frederick Barbarossa (1122-1190) was finally defeated.

In 1218, the *Palazzo della Ragione* was inaugurated for the administration of justice. The Palace was the symbol of the so-called *Patavina libertas* (Paduan freedom) because there any private citizen could report a *Signore* (Lord) of oppression or injustice, and all juridical disputes were solved. Here the study of Roman law was between the most advanced in

1 Vesalius 1543, p. 3.

2 Padua was very important both for its strategic position as an ultimate defence point against barbarian populations of North Europe, and for its famous horse breeding, which made it the main supplier of horses to the Roman army.

3 The Lombard League was a politic alliance formed in 1167 by some cities of the Northern Italy to counter the attempts by the Holy Roman Emperors to include this Italian area under the influence of their Empire.

Europe, representing an element of continuity between classic and medieval times. Its centrality in the whole economy of the town is demonstrated by its connections: through a bridge on its west side, it was connected with town prisons; through a similar bridge on the opposite side, it was connected with the halls of the General Council and the Council of the Olds. On the north and south sides, two big squares hosted shops and markets of any kind of good. In 1277, the General Council was composed of about 1000 members taken from an eligible population (adult males) which counted no more than 11.000 individuals. In other terms, there was a high participation of the population to the political administration of the town. The commune of Padua was a sort of "republic" where citizens' corporations could directly express their interests in the political life.[4]

In 1222, a group of students and professors left the University of Bologna, the first university in the western world founded in 1088, because the town administrators did not recognize their privileges and rights. They came to Padua, which already hosted private schools of law and medicine,[5] as well as the *Palazzo della Ragione*. Due to its cultural freedom, it was the ideal place where to inaugurate a new university. It was established spontaneously, not *ex privilegio*, which was a special decree of the Emperor or the Pope needed at that time,[6] as a *universitas scholarium*, that is, a university founded, organized and managed by students, not by professors, with the aim to guarantee their rights and the legal recognition of their studies. In some sense, the University of Padua followed the model of freedom and autonomy represented by the *free commune*. Through a continuous negotiation between the members of the university and the civil authorities, the students obtained a partial autonomy from the civil jurisdiction, because they were under the authority of the Dean of the University, who was himself a student. They obtained autonomy from the communal taxes and other duties required to citizens. They were also partially free to choose the professors and to change them when they were not satisfied of the quality of teaching. In this way, the University of Padua, from its origin, became a sort of "state within the state" and its autonomy was the crucial feature

4 Zampieri 2020, p. 13.

5 Rossetti 1983, p. 7.

6 Ibidem.

of what much later became the University motto: *universa universis patavina libertas*.[7]

Middle age culture, imbibed by the Christian doctrine, was characterized by a devaluation of the natural world as well of the human body, at the point that diseases could be considered a way for expiating human sins. Theology was not only the queen of sciences, but also a model for the other forms of human knowledge. Given that theology was a speculative form of thought, all the other disciplines adapted to this ideal, including natural philosophy and medicine. Medieval scholars investigated "nature without nature", that is, analysing Aristotelian categories or Platonic ideas without considering the real and concrete world.[8] Similarly, medieval physicians often refrained to touch the patient and to investigate the inner body, limiting themselves to study few external signs and grounding anatomical knowledge on the Ancient and Arabic texts.[9] Because of this devaluation of the body, surgery was considered an inferior part of medicine in any part of Europe where Middle Ages culture dominated. On the contrary, in Padua and some other Italian Universities, surgery was an integral part of medicine. Significantly, the first renewed doctor of the University of Padua was a surgeon, namely Bruno da Longobucco (†1268), author of two important handbooks on surgery: *Chirurghia magna* (1263) and *Chirurgia parva*.[10]

In Padua, the elements of continuity between classic antiquity and Renaissance prevailed, at the point that it is difficult to individuate the typical characteristics of Middle Ages.[11] It is even possible to support that Padua never knew an authentic medieval period with its devaluation of the human body, the natural world and any form of empirical knowledge. Moreover, since the late 13th century a new way to look at the classic times and to imitate the classic works developed in Padua. This culture, in turn, represented a fundamental prerequisite for the birth of modern science and medicine during the Renaissance.

7 Zampieri 2020, pp. 13-15.

8 Murdoch 1982, pp. 171-172.

9 Cassirer 1943, p. 111.

10 Mont D'Arpizio 2020.

11 Le Goff 1982, p. 59.

Between 1318 and 1405, the city became a *Signoria* under the Carrara family,[12] a further step of its cultural growth.[13] Carrara embodied the main authority in the town, but they also allocated political and administrative tasks among the professional corporations preserved since the previous free commune. The family ruled the town continuing the freedom typical of the previous times, that of *Patavina libertas*, a specific cultural trait of the Carrara government, significantly inspired by the ideal of the *Res Publica Romana*.[14]

Carrara family hosted at their courtship an important circle of men of letter and scholars such as Lovato de' Lovati (c. 1240-1309), Pietro d'Abano (1257-1316), Albertino Mussato (1261-1329), Dante Alighieri (1265-1321), Jacopo Dondi dell'Orologio (1290-1359), his son Giovanni (c.1330-1388), and Francesco Petrarch (1304-1374). The family favoured the study of classic literature and science. One of the symbols of this prehumanism was the *Sala dei Giganti* (Hall of the Giants), the boardroom of Carrara Palace in the centre of the town. The hall was decorated by a cycle of frescos, now lost, and inspired by Petrarch's *De viris illustribus*, which celebrated the lives and the moral values of illustrious men in the history of Rome.[15] Another significant example is given by Lovato de' Lovati, a notary with a deep interest in history and classical letters, realized also by collecting and copying old Greek manuscripts. In 1274, during an excavation near his home, a big skeleton was found, with some part of the skull presenting mummified tissues, as well as gold coins and a sword near to it. Lovati did not hesitate to identify the remains with Antenor, the mythic Trojan founder of Padua in 1132 BCE, after he had escaped from the defeat of Troy by the Greeks. The legend was divulgated by the famous historian Tito Livius (64 or 59 BCE-17 CE), born in Padua, as a way to connect Padua and Rome, as both were founded by a Troyan hero. In 1283, Antenor remains were buried in a monumental tomb still visible today, and Lovato was buried in a similar sepulchre behind it. Re-exhuming the history and even the possible body of Antenor, Lovato aimed to revitalize the knowledge of the classic roots of Padua's origin.

12 Collodio 2005.

13 Jones 1997.

14 Pastore Stocchi 2005; Ronconi 2005.

15 Mommsen 1966.

Commissioned by Enrico Scrovegni (died after 1336), Giotto di Bondone (1266-1337) painted the Scrovegni Chapel between 1303 and 1305, which is considered the earliest model of Renaissance painting and one of the masterpieces of the Western art.[16] Giotto, for the first time in Europe, painted the emotions by facial expressions and bodily attitudes. He was able to give three-dimensions to his painting by sculpting with colours. This approach clearly attests an authentic interest toward real man, with his passions and emotions, and nature, in contrast with the Middle Ages approach, more focused in God and theological virtues.[17] A renewed interest which was doubtless favoured by the presence of the classic literature and philosophy in the cultural circle of the Carrara. Giotto painted also the interiors of the *Palazzo della Ragione*,. The astrological circle reproduced several figures of Pietro d'Abano *Astrolabium planum*.[18] Through this system of symbols, it was possible to calculate the dominating astrological sign with the ascending for any day of the year, as well as the entire horoscope. The ceiling of the hall had, and still has, the form of a hull vessel and the *Palazzo della Ragione* was imagined as a *ship to navigate the sky*. It is important to underline that, according to Pietro d'Abano, astrology was an authentic natural science, not a form of speculation without scientific base. He considered the planets having an effect on nature and men by some form of physical force like a flow of particles from the planet to the earth. Astrological signs, ascending and horoscope were calculated on the base of the zenith at which a planet was at noon of the birthday of individuals. Therefore, also this monument attests in Padua a culture oriented toward the study of physics, rather than metaphysics, much earlier than other European areas.

After having studied Greek and ancient sciences in Constantinople, Pietro d'Abano was professor in Paris and Bologna, and eventually became professor of medicine and natural philosophy at Padua University from 1306 to his death. He died by tortures following the last of the three trials for heresy because of his theories. Significantly, he questioned the supernatural nature of Jesus Christ's resurrection, supporting that it could be explained as a case of apparent death. He wrote a famous book,

[16] Derbes & Sandona 2008.

[17] Murdoch 1982.

[18] D'Abano 1488.

the *Conciliator differentiarum philosophorum et praecipue medicorum*, in which, by conciliating Greek and Arabic sciences, he developed a mixture of astrological and empirical approach to patient and disease.[19] In this book, he demonstrated to be one of the first *scientists* able to read the original works of Greek authors, not the Arab translation which dominated during the Middle Ages.[20] On the one hand, he advised to make venesection only during precise lunar phases. On the other hand, he studied the abdominal muscles for advancing the surgical operation of paracentesis. That the knowledge on these muscles was functional for doing the abdominal paracentesis in case of ascites, means that anatomy was a fundamental knowledge for practical medicine and surgery. Another interesting point is that he strongly believed that the confidence of a patient in their doctor was a condition which could improve the effectiveness of drugs and therapies. Pietro d'Abano was one of the most prominent representatives of Padua new culture aimed at emancipating the study of nature from theology.

A similar figure of physician and astrologer was Jacopo Dondi dell'Orologio. Born in Chioggia, little town at the border of the Venetian Laguna, after having been elected municipal physician in Chioggia in 1313, he was called at the University of Padua as professor of medicine and astronomy thanks to the fame gained as builder of *Astrarium*. He supervised the construction of a large public clock with a dial that indicated and struck the hours from 1 to 24, and also displayed the age and phase of the moon and the place of the sun in the zodiac. His second son Giovanni, between 1365 and 1384 built a highly complex astronomical clock and planetarium, to describe and model the solar system through a sophisticated machine. It was composed of eight quadrants, one with an indicator of the hours, one with an indicator for the position of the moon, one for the position of sun, the others for the position of Jupiter, Mercury, Mars, Saturn and the constellations, respectively. It also continuously visualized the juridical, civil, and religious calendars. Dondi described the project of his machine in a series of manuscripts named *Tractatus astrarii*, now preserved in the *Biblioteca Capitolare* of the Padua Episcopal Curia (codex D39). This *Astrarium* was the tangible translation of the idea that mechanical movement and mathematical

[19] D'Abano 1473.

[20] Thorndike 1942; Piaia 2020.

principles could describe the universe, an idea which became the foundation of scientific revolution only two centuries later.

Compared to other European centres, Padua had an older anatomical traditions and anatomy, performed on human cadavers, and was conceived an important discipline since the middle age. The statues of the University of the second half of the fiftheenth century contained the disposition about the annual anatomy, *De anathomia singulis annis fienda*. Two cadavers of executed criminals were granted any year to anatomical demonstrations for medical students. Given that they were explicitly based on older programs, this same program should have been practiced in the previous century.[21] The first anatomical dissection of which he has notice dates back to Pietro d'Abano. In his *De venenis*, composed around 1303 and published for the first time in 1473 as appendix to the *Conciliator*, Pietro d'Abano reported the case of an apothecary died for an accidental ingestion of mercury. He dissected his cadavers to ascertain the cause of death.[22] Gentile da Foligno (†1348), professor of medicine in Padua from 1337 to 1345, reported the second historical case of dissection, done in 1341, during which he found a gallstone. The case was published as a supplement in the *Anatomia corporis humani*,[23] which was the 1493 edition of the essay on anatomy by Mondino de' Liuzzi (1275-1326), Bologna professor of medicine who wrote this treatise around 1316 and published for the first time in 1475/1476.[24] Da Foligno and de' Liuzzi were both pupils of the bolognaise professor of medicine Taddeo Alderotti (1215-1295), in the circle of whom human dissection seem to have begun in the Western university.[25] The *Anothomia* was the first University handbook designed specifically for taught how to make a dissection on human cadavers, with the merit to be synthetic and to use a form of Latin closer to vernacular than to the literary one. It is worth mentioning that Mondino's anatomy remained strictly related to medieval culture, because it was based on the scholastic categories of *accessus*. The *accessus ad auctores* was a formal introduction setting out a number of topics to be treated by medieval scholars in commenting on the

[21] Premuda & Ongaro 1965-1966.
[22] D'Abano 1473.
[23] Mondino 1493.
[24] Mondino 1475-1476.
[25] French 1979, p. 465.

classical authors. Dating back to Ammonius, a 5th century commentator on Aristotle, the anatomical *accessus*, that is, a formal introduction for treating human anatomy, dated back to the Byzantine medical writer John of Alexandria (c. 600-642 CE). In commenting Galen's *De sectis*, where Galen discussed if anatomy and vivisection were useful for medicine or not, John proposed an *accessus* type of rote that applies to each of the body's organs in turn, based on the following categories: substance; quantity (number); quality (e.g. bone, fibre or cartilage); place; relation.[26] The styles and details of the *accessus* were flexible and interchangeable, and later commentators added to the list, in first place, the name of the part. In *Anothome*'s Prologue, Mondino imitated John of Alexandria *accessus*. To the six original categories, he added two derived from vivisection ("necessity" and "operation"), by which the anatomist should try to understand the function of the organ in the living body, and a ninth, "disease", which was one the purposes of his anatomy to uncover.[27]

The course of studies in medicine in the 15th century lasted up to about three years, and only three disciplines were considered: Theoretical Medicine, Practical Medicine and Surgery. The first two chairs had a specific program for each of the three years of study.[28] Theoretical Medicine, in the first year, called for the study of the first Canon of Avicenna, in the second year the Aphorisms of Hippocrates and the comments of Galen, in the third, finally, the *Articella* of Galen. Other classical and Arabic texts were considered only in the case a professor was able to complete the program before the end of the lessons. Practical Medicine was devoted to the discussion of clinical topics, such as *De febribus* for the first year, *De morbis particularibus a capite usque ad cordem* for the second year, and *De morbis particularibus a corde infra* for the third year. The clinical cases discussed for any one of these particular diseases were taken from the classical literature, not from the practical experience of professors, in particular from Avicenna and Rhazes. However, even if the study of medicine was based on classic literature, mainly Hippocrates, Galen and Arabic authors, professors of these chairs published important works enriched with their personal, clinical, and sometimes

[26] Ivi, p. 464.
[27] Mondino 1475-1476, pp. 3-4.
[28] Ongaro 1980, pp. 76-77.

even anatomical, experiences. Finally, Surgery also included the study of Anatomy and the professor was obliged to give an anatomical demonstration each year. These programs remained almost unaltered until the second half of the 18th century, even if new chairs were gradually included in the medical curriculum, such as those related to botanic and clinical studies.[29]

Pre-vesalian medicine in Padua University

From 1405, the Venetian domination of Padua allowed to a further development of classic and scientific culture, thanks to the investments of the *Serenenissima* in the University, the maintenance of its *Libertas docenti et investigandi* (freedom of researching and teaching), the call of best professors from foreign countries, the circulation of classic rare manuscripts, their translation and publication.[30] Venice's administrators focused their attention to the improvement of the so well advanced classical and scientific studies at the University, which became the first and unique cultural centre of the whole *Serenissima* Republic.[31] Venetians knew that the University was a great chance to replace the culture of Carrara with one celebrating their illuminate government. They used the University as an ideological instrument to justify its domination in Northern Italy, as well as to interlace diplomatic relationships with other European countries, thanks to the reception in Padua of students coming from foreign aristocratic families. From the viewpoint of Venice, the university had become more important than the town in which it was located.[32] This situation, even if coming out from a cultural genocide by the Venetians toward the glorious past of Padua, favoured the creation of one of the most important scientific centres of Europe in all the history of science and, in particular, in the history of the Renaissance. As

[29] See: Ongaro 2001, pp. 171-188.

[30] Other than its status as a maritime authority, Venice also expanded in the Italian mainland; at its full expansion, it dominated a great part of northeast Italy, the Dalmatian coast from Istria to Albania, the Greek Peloponnese, Crete and Cyprus. Its rule has been on average well accepted by the dominated populations, because Venetian administrators left adequate independency to local authorities and favoured economic prosperity to the ruled states. See: Zampieri et al. 2013.

[31] Gallo 2001.

[32] O'Malley 1964, p. 74.

counterpart of the *damnatio memoriae* of Carrara family and the suppression of the *Patavina Libertas*, Venetians maintained and improved the *Libertas docendi et investigandi* of Padua University, creating an ideal environment, tolerant and international, for the spreading of new scientific ideas. In this period, the University of Padua became the centre of "Scientific Renaissance", as Florence was the centre of "Artistic Renaissance".[33]

Between 1516 and 1528, Venice established the institution of three "Riformatori" for the cultural and economic administration of the University of Padua. They were delegated by the Great Council of Venice to rule the University and to secure freedom and tolerance for students and professors coming from all Europe. For instance, one of them, Leonardo Donato (1536-1612), contributed to the call of Galileo Galilei (1564-1642) to Padua, favoured the construction of the anatomical theatre under the teaching of Fabricius (on whom we will return below), and defended the autonomy of Venetian Republic. Interestingly, Donato became Doge of Venice when Galileo started to use the telescope to investigate the moon, the Milky Way, Venus, and Jupiter.[34]

Thanks to the favourable political context, at the University of Padua we attest one of the first and most important reactions against philosophical and medical scholastic, and a growing attention to the practice, rather than to the theory in philosophy and science. Aristotle philosophy remained at the centre of investigations, but the focus changed from metaphysic to his method for naturalistic studies. According to Pietro Pomponazzi (1462-1525), one of the most important Aristotelians in Padua, nature must be observed and studied with its own principles and laws and without recurring to external, metaphysical forces.[35] Similar ideas were later developed by Bernardino Telesio (1509-1588), who studied in Padua from about 1527 to 1535, in particular with his most significant book, *De rerum natura, iuxta propria principia*.[36] Although Telesio criticized Aristotle's metaphysical ideas, he applied the empirical method of his naturalistic studies. Telesio, in turn, influenced many early modern philosophers and scientists, and Francis Bacon (1561-1626)

[33] Premuda 1983.

[34] Zampieri et al. 2013, p. 3.

[35] Premuda 1963-1964.

[36] Telesio 1586.

among others. In *Novum Organum*, Bacon evoked Telesio and Vesalius, stating that: "Better is to dissect nature than to abstract her".[37]

The most interesting late protagonist of Padua scientific Aristotelism was Jacopo Zabarella (1533-1589). Analysing Aristotle's epistemology, he elaborated the *resolutive method*, a method of natural investigation through which the researcher, first, from the known effects tried to rise to the unknown causes; second, from the discovered causes, he returned to explain the effects. Zabarella did not conceive the second part of this method such as an experimental verification of the theory, as if it was within the scientific method born with Galileo.[38] However, he indirectly favoured a deeper attention to empirical evidences in natural philosophy, because they were both the starting point and the ending point of scientific research. All these philosophers pioneered a new approach to nature that influenced the emergence of early modern natura philosophy.

In Padua, the interest in classic literature and science favoured a cultural environment ideal for the development of the most important Medical School in Europe between the second half of the fiftheent and the beginning of the seventeenth century. A medicine based on the direct observation of human body and diseases, with particular attention to the clinical symptoms, as in the Hippocratic School, and to the anatomical structures, as in Galen example. This was due firstly by a further improvement in the knowledge of classic science by the printing of the works of Aristotle, Hippocrates and Galen in their original language. In the fiftheent and sixteenth centuries Venice became, soon after the invention of mechanical movable type printing by the German Johannes Gutenberg (c. 1398-1468) in 1452, one of the most important European centers of printing. Many manuscripts of Greek literature and science flowed into Venice and were printed for the first time in their original language and in translations based on a rigorous philological method. Cardinal Basilios Bressarion (1403-1472), for instance, in 1468 donated to the town his library, composed of byzantine manuscripts saved from the Ottomans, who were building their empire during these times.[39] Bressarion was a fundamental figure for the preservation and diffusion

[37] Bacon 1620, p. 15.

[38] Poppi 1972, p. 193.

[39] Setton 1956.

of Greek culture in Europe. During the Middle Ages, Greek science was principally studied through Arabic writings, and indeed many classical works were known only through the Latin translation of the Arabic versions, which very often represented only a part, or a summary, of the Greek original works, in addition with the Arab interpretation. The rediscovery of Hippocrates and Galen in their original language marked an important advance in the knowledge of medicine.[40] Most famous were the editions of Galen's texts and Aristotle's *Opera omnia* by the Venetian humanist and publisher Aldo Manuzio (1449-1515), in 1525 (posthumous), and between 1495 and 1498, respectively.[41] These publications, however, represented the outcome of a process of translation and philological interpretation of classic Greek and Latin literature, science and medicine started already since the end of the fiftheenth century. The rediscovery of Galen and classic science pushed Padua professors to study more carefully clinical phenomena, to give more attention to practice, rather than to theory, and probably this has been also at the base of a renewed attention to the anatomical structure of man. Aristotle himself, in the *Metaphysics*, stressed the importance of experience in medicine: "[...] if [the physician] knows theory without practice [...] he will miss the cure many times" (Metaphysics, 980a, 3-4). The limit of Aristotle and Galen, however, was that their approaches were based on a finalistic and qualitative view of nature, which was incompatible with modern science.

[40] This statement is a simplification, because there are proofs that original Greek texts circulated in Europe also during the early Middle Age: Gouguenheim 2008. However, it can be safely supported that the influence of Arabs, represented by eminent scientists such as Avicenna (980-1037) and Averroes (1126-1198), was determinant for shaping medieval European culture. It is clear also that, during late 15th and 16th centuries, a more rigorous philological approach to Greek texts paved the way to the revolution in natural sciences and medicine. In Padua, as we have briefly seen, Lovato de' Lovati collected and copied old Greek manuscripts already since the 14th century.

[41] To these works contribute also a group of British physicians who came at Padua during that period. Thomas Linacre (c. 1460-1524) is among the most renewed, given that, after returning in London, he contributed to the foundation of the Royal College of Physicians, which is still now the most important medical institution of the United Kingdom. Linacre is commemorated in the Aldine editions of both Aristotle and Galen, while Andrea Torresani (1451-1528), in the preface to Galen's *Opera omnia* published by Aldino, mentioned four "*Britos*" for their help in the edition. They were John Clement (1500-1572), Thomas Lupset (c.1495-1530), Edward Wotton (1492-1555) and William Rose (15th-16th cent.), all from Oxford. It is clear, therefore, that British students, as well as other foreign students at the University of Padua, looked to this classical knowledge, which, as we have seen, was typical of the culture of Padua from the time of the rule of the Carrara in the previous century: Zampieri 2016, pp. 32-33.

Therefore, Aristotle and Galen have been the starting point for the birth of modern science, but they must be overcome for its complete development. Vesalius represented, in medicine, the first step of the medical emancipation from a strict Galenic orthodoxy.

Among the most significant figures of physician in Padua of the first Venetian period, there was Michele Savonarola (c. 1384-1466), professor of practical medicine between 1434 and 1440, when he left Padua to become court physician to Niccolò III d'Este (1383-1441) in Ferrara. He wrote the *Practica de egritudinibus a capite usque ad pedes*,[42] which consisted of carefully observed and described clinical cases, with discussions on diagnosis and therapy, and important observations about the frequency of the pulse. The focus on the minute analysis of clinical cases enriched with his own practical experience represented an innovative feature compared to the typical medical treatises on pathology of that time. He wrote also one of the first works on paediatrics, *De regimine pregnantibus et noviter natorum usque ad septennium*. Following the introduction of printing, his books were widely diffused, and his fame grown exponentially. As an example, in the satirical play *La Mangragora* (The Mandrake), written by Niccolò Macchiavelli (1469-1527), first published in 1524 and considered a masterpiece of Renaissance theatre, one of the protagonists, Callimaco, literally repeated phrases from Savonarola's works for letting believe the others that he was a physician.[43] Among other works, in *De conficienda acqua vitae* Savonarola designed new instruments for distilling and flavouring the grappa with aromatic plants, which improved the international Venetian commerce of spirits. He was inspired by the methods described, in alchemic terms, by Avicenna and Razhes (865-930). In other words, Savonarola improved a theoretical knowledge, taken from Arab alchemy, for practical purposes.

Many of the most important pre-Vesalian anatomists were seated or have studied in Padua, such as Gabriele de Zerbi (†1505), Alessandro Benedetti (1450-1512) and Nicolò Massa (1485-1569). De Zerbi published the *Liber anathomie corporis humani et singulorum membrorum illius* in 1502.[44] It was a comprehensive review of the anatomical knowledge disposable at that time from the Greek, Arab and Medieval sources, according to the scholastic approach. De Zerbi is also known for the first textbook on geriatric disorders, the *Gerontocomia scilicet de senum cura atque victu*.[45] Massa published in 1536 the *Liber introductorius anatomiae*, where for the first time he described the anatomy of the prostate and discovered the cerebrospinal liquid. As stated by Cynthia Klestinec: "Drawing on Galen, Mondino, and Avicenna, Massa encouraged the anatomical method of anatomia sensata, which relied on things actually sensed, or sensually apprehended, rather than […] merely potentially perceptible".[46] Moreover, Massa disapproved physicians who pretended to discuss about disease without practice and anatomy *neque oculis viderint, neque manibus tetigerint*.[47]

Alessandro Benedetti was probably the most important among them. He published the *Historia corporis humani sive Anatomice* in 1502.[48] Here he described a model of a temporary anatomical theatre to be used for public dissections and lectures, the same model probably used by Vesalius during his professorship in Padua. Anatomical lectures were done only during the winter for better preserving human corpses. Benedetti described a wooden structure, "on the model of the Roman ones in Rome and Verona", which could be assembled for the begging and disassembled at the end of anatomical lectures.[49] Therefore, it was an amphitheatre with roundish plan where the professor of anatomy was significantly placed at the centre of the scene, in front of the anatomical table, performing the dissection with his own hands. Contrary to what is supported by most of historians, there are no documentary proofs that Benedetti was professor of medicine in Padua. Most probably, he built and used his temporary theatre at the Medical College in Venice, which at that time hosted a medical school almost as much important as the Padua's one.[50] Even if Benedetti was inspired by Mondino's *Anothome*, Mondino's language was embedded with Arab lexicon, showed vernacular influences, and was structured according to Scholastic categories, while Benedetti tried to create a specialist anatomical lexicon based on

[42] Written around 1440 and published in 1486: Savonarola 1486.
[43] Hale 1960, pp. 275-291.
[44] De Zerbi 1502.

[45] De Zerbi 1489.
[46] Klestinec 2011, p. 31.
[47] Massa 1536, p. 14.
[48] Benedetti 1502.
[49] Ivi, p. 5.
[50] Ferrari 1998, p. 11.

Greek terms. Benedetti owned one of the best collections of Greek manuscripts of his time, collected through his voyages in Greece, the Dalmatian Coast, Crete, and around the Mediterranean.[51] For instance, Benedetti recovered many specific words from *De medecina* by the roman encyclopaedist Aulus Cornelius Celsus (c. 25 BCE - 50 CE), a fundamental text which was rediscovered only few decades earlier.[52] In that period, also the major Galenic treaties on anatomy were rediscovered, the knowledge of which, in fact, was poor in Mondino's work.[53] Benedetti, moreover, showed to be influenced by the debate on technical language to which, in this same period, the humanist Giorgio Valla (1447-1500) gave an important contribution with a monumental encyclopaedia published in 1501 in Venice, where he taught Greek and Latin from 1485 to his death.[54] Interestingly, by his work he aimed at clarify any areas of knowledge with the idea that any term and definition had to be founded on *res*, the real and concrete features of the objects. Similarly, Benedetti tried to elaborate anatomical descriptions and definitions with a simple, clear and concrete language, on imitation of the best Latin science and erudition. The writer, according to Benedetti, has to "express the objects on which is speaking with clarity, almost letting see them".[55] As regard to anatomical lexicon, he compiled a terminological index at the end of the book in which it is possible to appreciate that he often preferred to maintain the anatomical Greek term with a simple transliteration, rather than proposing a Latin equivalent.[56] It was not easy to find the right words for technical terms for which no equivalent existed in the slight corpus of Latin scientific literature. Celsus, virtually unknown in the West until 1426 and the principal source of Benedetti and Renaissance medical terminology, could not be enough. Moreover, Benedetti's *Anatomice* final bibliography comprehended also a choice of Greek authors (Hippocrates, Plato, Aristotle, Galen, Rufus of Ephesus, Alexander of Aphrodisias), which, as such, was revolutionary at that time. It represented a program of restoration and imitation of classic science which continued in the

[51] Ferrari 1996, pp. 80-82.
[52] Ferrari 1998, p. 14.
[53] French 1979.
[54] Valla 1501.
[55] Benedetti 1502, p. 62.
[56] Ivi, pp. 66-69.

following century and deeply influenced also Vesalius himself, as I'll mention below.

Finally, in the Dedicatory of the work to Maximilian of Habsburg (1459-1519), Benedetti listed the reasons why a work on anatomy could be useful for an imperator. First, anatomy was a practical knowledge necessary for medicine and surgery. Also in his treatise on pathology, the *Singulis corporis morbis a capite ad pedes [...] remedia, causae eorumque signa*, Benedetti stated that "[...] to make dissections of cadavers is useful for discovering the specific origins of disease".[57] Second, but not less important, anatomy revealed the microcosm of the human body created by God in the form of a little world reflecting the macrocosm. In his words:

> Divine imperator who excels in faith, uses and doctrine, when you will have finished learning anatomy, after having admired the deepness of the nature and the structure of God's mysterious creature, you will venerate with more carefulness and faith this God who created the world and all the things, because he did not invent anything in vain. And you will turn your gaze more promptly to the conformation of the universe, of which the man reproduces, in little, the aspect.[58]

In this sense, anatomy was not only a crucial instrument for medicine, but also a fundamental philosophy of nature, by which it was possible to study the man and the nature as a whole, worth of the interest of a king like Maximilian. Regarding the study of man, let us mention that anatomy was useful also for moral philosophy, because the study of viscera, brain and heart could give further indications for the control of instincts, passions and will according to the localization of the three souls in Plato's *Timaeus*. For this approach, Benedetti was considered a "platonic" physician in the humanistic circle where he operated.[59] Because of this interpretation of anatomy such as a philosophy of nature, Benedetti's *Anatomice* represented a step further compared to Mondino's *Anothome*. This conception paved the way to the revolution made by Vesalius and to the "theatralization" of anatomy during the sixteenth

[57] Benedetti 1533, p. 9.
[58] Benedetti 1502, p. 6.
[59] Ferrari 1998, p. 22.

and seventeenth centuries, which brought this science well beyond the boundaries of a medical discipline.[60]

Vesalius scientific revolution

The activity of Andreas Vesalius and his followers at the Padua chair of anatomy – as well as other physicians in other chairs such as practical and theoretical medicine, and botany – coincides with the golden age of the University of Padua, lasted from 1530 to 1610. During this period extraordinary figures such as Vesalius, Matteo Realdo Colombo, Gabriele Falloppia, Hieronymus Fabricius ab Acquapendente, Giulio Casseri, Santorio Santiorio, and William Harvey gave fundamental contributions in rediscovering Classic science, paving the way to early modern human anatomy, physiology and clinics.

Moreover, there is a significant feature, emerged in that period, which best exemplifies the freedom of thought and attractivity of the University of Padua. After the Catholic Reformation, the University of Padua remained the only university under the Catholic reigns still open to Protestants students and professors. In fact, it became the favourite academic destination for north Europe students, who were largely Protestants.[61]

Andreas Vesalius had a humanistic education both in Leuven and in Paris. In Leuven he learnt Latin, Greek and Hebrew. His degree thesis in medicine, published in 1537, consisted in a paraphrase on the ninth book *ad Almansorem* of Rhazes. He knew Greek so well to be able to read Galen in his original language.[62] In Paris he was influenced, in particular, by Gonthier d'Andernach (1587-1574), who translated from Greek to Latin many books of Galen and was professor of Vesalius also in Leuven, and Jacobus Sylvius (1478-1555), professor of anatomy.[63] Sylvius, even if was the first to teach anatomy in France with human cadavers, considered Galen an indisputable authority and he would have been, later, an opponent of Vesalius because of his anti-Galenism.

[60] See, for instance: CUNNINGHAM 1997.

[61] ZAMPIERI ET AL. 2015, p. 3.

[62] BURGGAEVE 1841.

[63] ZAMPIERI ET AL. 2015, p. 1.

In 1537, Vesalius travelled to north of Italy. He went to Padua principally because anatomy was a prominent discipline, as proven by its long tradition and the recent works of Benedetti, Zerbi and Massa. Moreover, in Padua Vesalius could easily find all Galen and classic works in their original language and in Latin translations based on advanced philological methods, and he could enjoy of the classic culture as well as the freedom and tolerance which characterized not only the University, but also the whole town since the thirteenth century.[64] The Galenic treatise *De usu partium* was translated in Latin at the beginning of fourteenth century by Niccolò da Reggio (born 1280) of the Salerno school of medicine, who between 1308 and 1345 or later translated some fifty treatises of Galen, and his version of *De usu partium* was never supplanted.[65] However, it was scarcely used because considered long winded.[66] Instead of this work, anatomists such as Mondino used the *Juvamenta membrorum*, which was a Latin translation of an Arab summary of the first nine books of Galen's *De usu partium* (which consisted of 17 books).[67] More important was *De anatomicis administrationibus*, being the real Galen's handbook on "technical" anatomy, which started to circulate only at the beginning of the sixteenth century. Vesalius was surely influenced by the translation made by his Paris' master Gonthier d'Andernach, who published the Latin version of *De anatomicis* both in Paris and in Basle in 1531, republished in 1546 and 1551,[68] "*that started Vesalius on his triumphant carrier*".[69] However, the earliest rigorous translations were at disposal in North Italy, and particularly in the Venetian area. Nicolaus Leonicenus (1428-1524), born in Vicenza, professor of medicine at Padua and then at Ferrara University, uncovered and collected manuscripts which were fundamental for the editions of the works of Aristotle and Galen by Aldo Manuzio. Moreover, it is to him that we owe the edition of the first genuine Greek texts of Galen, namely the *Methodus medendi* and *Ad Glauconem*, published in Venice in 1500.[70] The first Latin version

[64] On the "medical humanist" which flourished in Padua in the 16th century, see: BYLEBYL 1979 and 1985.

[65] DURLING 1961, p. 233.

[66] FERRARI 1998, p. 8.

[67] MONDINO 1475-1476, p. 3.

[68] DURLING 1961, p. 257, 283; GALEN 1531.

[69] SINGER 1956, p. XIII.

[70] DURLING 1961, p. 236.

of Galen's *De anatomicis administrationibus*, with the alternative title of *Anatomicarum aggressionum libri IX*, was published in Bologna, where Vesalius studied and dissected during his stay in Padua, inside the *Libri anatomici* edited by Berengario da Carpi (1466-1530), professor of Anatomy in Bologna, in 1529.[71] The manuscript of the translation, given that was done by Demetrius Chalcondylas (1423-1511), the eminent Greek scholar who taught in Padua, Florence and Milan, was ready well before the date of publication. After the death of Chalcondylas in 1511, it arrived in the hands of Berengario, who published it with other minor Galen's works, namely *De arteriarum et venarum dissectione*, *De nervorum dissectione* and *De hirunidibus*. That Chalcondylas manuscript circulated since the first years of 1500 is proven by the fact that it was quoted many times by Nicolaus Leonicenus in his famous work on the Roman naturalist Pliny the Elder (23-79 CE).[72] That *De usu partium* and *De anatomicis administrationibus* were among the less published works of Galen during the Renaissance, does not mean that they do not circulated among the physicians and the anatomists, particularly in Italy and Padua. Publishers in fact may have been chary of frequently issuing such lengthy works as them, which required great outlay on paper and print, preferring to issue the smaller treatises which would cost less, sell more quickly and constitute a slighter risk.[73]

Vesalius graduated in medicine in 1537, the same year he arrived in Padua, and the day after his graduation, he became professor of Surgery and Anatomy until 1543.[74] That the period of Vesalius' stay in Padua was fundamental for his scientific achievements, is proven by the fact that in his first publication on anatomy, the *Tabulae anatomicae sex*,[75] Vesalius represented some of the fundamental anatomical errors at the base of Galen's physiology. The *Tabulae* were innovative because based principally on illustrations, rather than verbal description of human anatomy, as all previous anatomical treatises, but these illustrations were still strictly related with Galen's orthodoxy. For instance, one of the Galen's

[71] Da Carpi 1529.
[72] Ferrari 1998, p. 8.
[73] Durling 1961, p. 243.
[74] Cushing 1962; O'Malley 1964.
[75] Vesalius 1538.

anatomical mistakes regarded the structure of human carotids.[76] Vesalius reported the same error, representing left and right carotids emerging from the *truncus communis*, which is a characteristic typical of simian, while in humans left carotid emerges separately from aortic arch. Only with the publication of the *De humani corporis fabrica* in 1543, at the end of his professorship in Padua, Vesalius proved that Galen's anatomy was widely wrong.[77]

With the *Fabrica*, Vesalius accomplished the process of cultural change from medieval speculative learning to the empirical knowledge of early modern times. As already stated, theology, a discipline essentially speculative, was the queen of sciences. Any practical knowledge was considered inferior to the speculative ones and natural objects, included the human body, were studied principally from a theoretical point of view. Following this same model, medieval physicians underestimated practical activity.[78] Since the Preface of the *Fabrica*, Vesalius revaluated the practical and manual activities of scientists, demonstrating that no theory could sustain without empirical observations and manipulations of natural objects. In doing so, he was fitting himself into a general approach to medical education which was already well developed in Padua. This approach, in turn, was in line with the rediscovery of the natural world and the correlated empirical knowledge made possible by the pre-humanistic and humanistic Padua culture developed since almost three centuries. A proof of the practical approach in medical education is given by Giovanni Battista da Monte (1498-1551), professor of practical medicine (1539-1542) and then theoretical (1543-1549) in Padua, who, as well known, took his students on rounds with him.[79] His example was followed by other professors of both theoretical and practical medicine in the last quarter of the 16th century: the transalpine students repeatedly praised these professors for their practical orientation.[80] Interestingly, Albertino Bottoni (d. 1596) and Marco degli Oddi (15126-1591), other than holding lessons in the Padua Hospital of Saint Francis, dissected patient died there.[81]

[76] Singer & Rabin 1946; Pagel 1964.
[77] Vesalius 1543.
[78] Flint 1989.
[79] Bylebyl 2005; Stolberg 2014; Shotwell 2015, p. 7.
[80] Klestinec 2011, p. 67.
[81] Zampieri & Zanatta 2014; Zampieri et al. 2014.

Vesalius complained that physicians have neglected the use of *hands*, underestimating the direct observation and study of nature:

> From the invasion of barbarians, medicine was lacerated to a point that its principal instrument, the use of the work of hands for the cure of man, was neglected and committed to people of low rank and not skilled in medical art [...]. Physicians by consequence neglected the oldest and primary branch of medicine, which is based on the investigation of nature.[82]

Anatomy had to be performed not (only) reading books but performing autopsies and basing anatomical descriptions in the anatomist's own observations. Already Alessandro Benedetti, closing the *Anatomice*, supported the same idea:

> As Plato says, the one who trusts only in the written proofs without well observing things and thinking about what he has observed, makes often mistakes and delivers mere opinions to his mind rather than the truth.[83]

Deeply in contrast with medieval culture, surgery was, according to Vesalius, a fundamental part of medicine, not a separate one, as it would have been in Europe even after his revolution and until the 18th century. The importance of surgery for medicine and its strict relationship with anatomy, was an idea perfectly in line with the statues and the culture of Padua, and it would be a characteristic of all its Renaissance medical school. All the Preface of the *Fabrica* can be seen as a defence of the "hands" in its contribution to the knowledge of the body and medicine.[84] According to Vesalius "when the hand is used, medicine flourishes; when it is neglected, medicine languishes; when it is restored to use, medicine can flourish again".[85] Interestingly, also Galen reserved a particular attention to the hand, but with a different perspective. The description of the hand in Galen's *De usu partium*, for instance, was "a long hymn to the Divine Wisdom in fitting the hand for its functions".[86]

[82] Vesalius 1543, p. 2.
[83] Benedetti 1502, p. 65.
[84] Premuda 1964.
[85] See also: Cunningham 1997, p. 63.
[86] Singer 1956, p. xix.

Vesalius' focus on the practical base of any human knowledge, embodied in his defence of the use of hands, had an important echo not only in medicine, but also in the philosophy and epistemology of the Renaissance. We have already mentioned Telesio. Also the philosopher Giordano Bruno (1548-1600) showed to be in the same line of thought, stating that: "The providence determined that man is occupied with his hands when he is in action, and with his intellect when he contemplates, so that he does not contemplate without action and he does not act without contemplation".[87]

Another fundamental feature of medieval culture, that Vesalius was able to reverse, is the evaluation of human body. The body, in the Middle Ages, was considered an object not deserving particular attention. The more a thing was remote from God, in fact, so much less was its grade of perfection and its value.[88] Given that earth, nature and human bodies were between the remotes things from God, between them being angels, celestial legions, stars and planets, they were neglected by medieval culture, science and even medicine. Vesalius, on the contrary, showed that human body was an extraordinarily complex structure, the study of which was the most effective also to show and prove the work of God. The body became, by consequence, the best object to study theology. Vesalius stressed this implication from the Preface of the *Fabrica*: "[...] the wonderful knowledge of the human body attests the wisdom of the immense Creator".[89] Anatomy was: "The description by which we can know the body and the soul and their harmony, such as a Divine spark".[90] The study of the body was fundamental not only to study the work of God, but also to understand the structure of the world, according to the analogy between microcosm and macrocosm which would become one of the leitmotiv of Renaissance culture. The body, in fact, was considered by Vesalius as the "refuge and instrument of the immortal soul, a structure that ancients correctly named microcosm, because for many aspects it corresponds to the world".[91] That anatomy, showing the complexity of human body, was a science useful to prove God's intervention,

[87] Bruno 1873, p. 24.
[88] Cassirer 1943, p. 110.
[89] Vesalius 1543, p. 9.
[90] Ibidem.
[91] Ivi, p. 10.

became one of the typical justification of this discipline even in the following centuries.[92]

The wide use of the new instrument of anatomical illustration by Vesalius can be seen as a consequence of this new attitude toward nature and human body. Given it was a noble, perhaps even the noblest object of study, the body deserved to be wonderfully and precisely represented. In Vesalius' *Fabrica* there are more than 250 illustrations, some of the whole body, some of specific organs and parts of organs, some of anatomical instruments and techniques.[93] Many of them shows cadavers in allegorical postures and imaginary, but realistic landscapes. The allegorical postures are used sometimes also to give moral messages, such as the Table IV of I Book, which shows a skeleton contemplating a skull. The skeleton leans on a monument, on which lies the skull. The monument bears the Latin inscription: *vivitur ingegnio, caetera mortis erunt* (Genius means life, all else will belong to death). It is a quotation from the *Elegiae in Maecenatem*, part of a collection of poems wrongly attributed to Virgil. For students of anatomy, the illustration was important as a fine lateral view of a human skeleton, but it could be read as an emblem of mortality. The person whose skull was on the monument was gone, and even the monument itself will pass away, but the genius that once resided in such a skull may survive. This motto probably expressed Vesalius' hope for his own scientific immortality.

A part the artistic value, it is undisputable that for Vesalius these illustrations had a scientific scope, that is, to realistically represent human anatomy. They were used as an instrument to overcome a fundamental limit of public dissection, that of availability of cadavers. Given that the cadavers supplied each year by the town administrations for the anatomical public teaching were not enough to perform a complete course of anatomy, Vesalius used the illustrations to substitute real corpses.[94] As mentioned, the illustrations from the *Fabrica* have been attributed to Jan Steven van Calcar, painter who worked at the Titian school in Venice.[95] It is interesting to note that Titian and Veneto school of painting, in that period, were particularly focused on the realistic representation of nature and human emotions, further developing Giotto's innovation. Probably Vesalius choose Von Calcar also because of his naturalistic style.[96] All of this, in turn, was functional to support the new scientific conception of Vesalius's discipline: "Anatomy is not an opinion, but a sure and demonstrative science".[97] Vesalius, in fact, compared the use of illustrations in anatomy to the use of them in demonstrative sciences for excellence: "Everybody knows that in geometry and mathematics figures are useful and are more evident even than a very detailed discourse".[98] Vesalius established a dialogue between the verbal and the visual, constantly using his images to explain his text, and vice versa.[99]

[92] Cunningham 2010, pp. 142-147.
[93] Saunders & O'Malley 1950.
[94] Shotwell 2015, pp. 13-15.
[95] Hazard 1996.

The practice of anatomy, the observation of anatomical structures in cadavers and the realistic reproduction of them trough illustrations were Vesalius' fundamental innovations, which gave him the possibility to finally overcome Galen's anatomy dominating European universities. As a humanist, Vesalius recommended his students to read directly the anatomy texts of Galen rather than Mondino. His ability to read Galen directly from Greek and the availability of Galen original works thanks to humanistic movement were the other elements which permitted Vesalius to accomplish his revolution. It was by the comparison between his personal experience in dissection and his direct knowledge of Galen's anatomy, that Vesalius could demonstrate the several errors of Galen's anatomy because it was based on apes and other mammals, and not on man.

However, it is important to stress that the context in which Vesalius made his researches could be characterized as a period of *Galen's renaissance*. Only with the Renaissance a genuine knowledge of Galen's though was possible because this period marks the first alliance of medicine and philology.[100] In the course of the 16th century, more than 630 editions of Galen's works were published all around Europe, where Paris (with 191 editions), Lyons (158), Venice (93) and Basle (39) together accounted for no less than 481 items.[101] Direct knowledge of Galen writings, revealed

[96] Premuda 1963-1964.
[97] Vesalius 1543, p. 9.
[98] Ibidem.
[99] See also: Nutton 2012, p. 416.
[100] Durling 1961, p. 236.
[101] Ivi, p. 243.

an amazing modern physician. Galen stressed the therapeutic importance of medical simples (the plants) in medicine, the educational value of experience (for clinic and physiology), of dissection (for anatomy), of travel (for the accumulation of medical knowledge), and of philosophy (for reasoning). He advocated the importance of original researches which were much more important than traditional knowledge, and he had a major focus on the progress of science than tradition.[102] The other side of the coin was represented by Galen's teleology, which prejudiced the Christian church in his favour, while his dogmatism appealed to a posterity which preferred easy acceptance of a system to painstaking research and experiment, despite Galen's own insistence on the need for individual observation.[103] The teleological approach, according to which any structure of the body had to be explained with a harmonic purpose established by God, even when no data were at disposal for understating the function of the parts, favoured continuous misinterpretations for long-time after the Renaissance.

Paradoxically, to be anti-Galenic in this period could be seen to be against progress in medicine, rather than to be against tradition, because Galen represented, in the mind of most Renaissance scholars, the most up-to-date medical knowledge. However, the error of physicians who did not accept Vesalius' demonstrations, as his master Sylvius, was based on thinking that Galen was infallible. Vesalius, probably understanding that by this discovery he would have acquired the immortal fame desired, did not hesitate to criticize Galen.[104]

Yet, this means that Vesalius attentively focused on Galen's work. It is thus wrong to claim that Vesalius utterly refused Galen. On the contrary, "he worked diligently through Galen's anatomy project".[105] In a sense, he even imitates Galen's work because his main ambition was to become the new Galen of medicine with regard to anatomy. It is possible to support, in a provocative way of course, that the *Fabrica* was a monumental "paraphrase" of Galen's *De anatomicis administrationibus*.[106] In the first part, both Galen and Vesalius marked the difference between their own

[102] See, for instance: Hankinson 2008.
[103] Durling 1961, p. 231.
[104] Vesalius 1543, pp. 5-6.
[105] Klestinec 2011, p. 377.
[106] Ferrari 1998, p. 9.

work and the previous anatomical knowledge, letting implicitly understand that their anatomy was the most advanced. Both Galen and Vesalius treated in separate sections, even if with a different order, the muscles and ligaments, the organs of nutrition, heart and lungs, and the brain. Vesalius, however, treated in two separate books also the venous and arterial systems, and the nerves, respectively. The main difference between the two works is that *De anatomicis*' first five books concerned myology, while *Fabrica*'s first book developed a detailed description of osteology, which can be considered the outstanding contribution of Vesalius in anatomy. Galen's *De anatomicis* does not contain an osteological part because he treated the issue on a separate work, *De ossibus*, which was discovered few years before Vesalius' arrival in Padua. It was translated in Latin for the first time by Ferdinandus Balamius (c. †1550) from Agrigento and published in Rome in 1535, then in Lyons and Paris in the same year.[107] In the following two years, it saw three more publications, one of them in Venice in 1538, the year of Vesalius' appointment at the Padua's chair of anatomy.[108] That Vesalius was inspired by Galen's *De ossibus* is proven by the first sentence in the *Fabrica*'s book on osteology, which sounds as follow: "The hardest and driest of all parts of the human body, bone is the most earthy and cold […]".[109] Galen described the nature of bones in the same way: "The bones are the hardest and driest parts of the animal, and, as one might say, the earthiest".[110] Therefore, Vesalius *Fabrica* was inspired from *De ossibus* in the first part, and them it followed *De anatomicis* for the remaining anatomical sectors.

That Vesalius maintained a strict relationship with books, that is, with classical authors, is demonstrated also by his careful attention to anatomical lexicon, following the example of Alessandro Benedetti and his *Anatomice*. He was surely influenced also by his Paris and Leuven professor Gonthier d'Andernach, who in the Preface of *De anatomicis*' Latin translation deplored the Latin vocabulary: "Hardly any of the best Latin authors can serve as our models when it comes to translating anatomy: in that sphere particularly the Greeks are better off than the Latin

[107] Galen 1535.
[108] Durling 1961, pp. 258-260, 288.
[109] Vesalius 1543, p. 7.
[110] Galen 1535, p. 5.

writers, being endowed with a far richer vocabulary".[111] In the *Tabulae anatomicae sex*, Vesalius presented, when possible, the Greek, Arab, Hebrew and Latin terms for the main structures he described, giving therefore the maximum lexical information at disposal in the European major languages. However, in the *Fabrica* he complained that medicine was invaded by foreign terms[112] and, in fact, he presented only Greek and Latin terms, discussing more widely the anatomical lexicon in the cases of bones and nerves. Vesalius' focus on anatomical terminology has recently found a further confirmation in the discovery of Vesalius' own copy of the *Fabrica* 1555 edition, heavily annotated in preparation for a never published third edition. Between hundreds of changes, at least two thirds of them, including the correction of earlier printers' errors, are concerned with words, and by far the great majority of them are stylistic. They do not alter the general meaning of the sentence, but display Vesalius' command of Latin and his constant concern about his choice of expression.[113] We can reasonably support that Vesalius' attempted linguistic improvement had, at the same time, a full scientific meaning.

The new morphological knowledge developed by Vesalius had many implications in the *Fabrica*. His work indubitably leaves an important part to the interpretation of the *function* of these new structures discovered. Even in this case he followed the example of Galen, whose *De anatomicis* contained many discussions on the function of the described structures. The knowledge developed in the *Fabrica* was surely a morphology of the human body, but Vesalius was well aware that to discover new structures inevitably brought to the need of discovering new functions related to these structures. In many points of the *Fabrica* he discussed on the function of the tissues and organs he was describing. In denying the pores in the interventricular septum in the second edition, he declared that this change would have brought to the discovery and description of a new cardiovascular physiology.[114] Finally, he advocated the practice of animal vivisection for the study of physiology.[115]

[111] Galen 1531, p. 4.

[112] Vesalius 1543, p. 3.

[113] Nutton 2012, pp. 424-426.

[114] Vesalius 1555, p. 746.

[115] Vesalius 1543, p. 53.

The other fundamental implication was related to the role of anatomy in understanding and curing human diseases, a role stressed by Galen, first of all, and then by Benedetti. In the *Fabrica* this role is underlined several times and Vesalius continued to use his anatomical knowledge also when he leaved the University of Padua for becoming court physician of Charles V and then of his brother Philip II of Spain (1556-1598). A significant episode dates back to 1555, when the doctors Adolph Occo junior (1524-1606) and Achilles Pirmin Gasser (1505-1577) asked Vesalius to come to Augsburg (South-Germany) to give an opinion on Leonard Welser, a gentleman with agonising and so far untreatable backpain. In 1609, Occo junior reported the medical history in a paper entitled *Aneurysmatis exempla illustria* (A famous case of an aneurysm), where he wrote that Vesalius, discovering a small pulsating tumour under the dorsal spine, declared it to be an aneurysm caused by a dilation of the aorta, which he predicted would be fatal. He stated that he had seen such a disease in the neck, the chest, the popliteal space, and the arm, and that it always was associated with excruciating pain. He finally added that this condition was incurable unless it was impossible to remove it, and that these aneurysms frequently contained a concrete fluid resembling ice or the crystalline humour, sometimes coagulated blood, or a polypus substance.[116] At autopsy, Occo junior and Pirmin Gasser found as predicted by Vesalius, a very large aneurysm protruding from the aorta, which was the source of the pain and the pulsations in the back.[117]

Therefore, in the work of Vesalius we can find the seeds which would have become the base of the modern medicine. We find, obviously, the prominent role in medicine given to the anatomical knowledge of the human body. Then, we find the first modern discussions on physiology, which developed in the 17th century, and the first demonstrations of the fundamental role of organ pathology, which emerged in the 18th century.

[116] Occo junior 1609, p. 787.

[117] Suy & Fourneau 2015. Another interesting case dates to 1559, when Vesalius was at the court of Philip II. The king of France Henri II (1519-1559) was shot in the face by an arrow, which perforated the right orbit and the temporal bone. Vesalius was called at his bedside with other physicians, among them the most famous was the French surgeon Ambroise Paré (1510-1590). The king died 12 days after the injury. Vesalius performed the autopsy and wrote a detailed clinico-pathological report, tracing a relationship between the symptoms of the dying king and the findings at autopsy (Eftekhari et al. 2015).

Even if Galen's system of medicine continued to be taught at the European Universities until the end of the 18th century, these seeds continuously growth in the private researches of West physicians until the plants could produce mature fruits, thus definitely changing the course of scientific medicine.

From anatomy to physiology: Acquapendente and Harvey

In 1595 a stable anatomical theatre was inaugurated in Padua. We cannot be sure that it was the very first structure of this kind in Europe. In Padua itself, for instance, a first structure was built between 1583 and 1584 in a hall of the upper floor of the Bo Palace, the main building of the University, where all the "faculties" were located. It was used for less than 10 years and then demolished.[118] The Padua anatomical theatre of 1595 immediately became famous all around the continent, being taken as model by other universities. A stable theatre was undoubtedly seen as an innovation. Following Padua, European universities built anatomy theatres to attract more students and more funding from their governments during the sixteenth and seventeenth century.[119]

The foundation of Padua anatomical theatre coincided with Hieronymus Fabricius ab Acquapendente professorship at the chair of anatomy. Born in Acquapendente around 1553, which at that time was part of the diocese of Orvieto (now it belongs to the district of Viterbo), around 1550 he moved to Padua for studying medicine.[120] He obtained the doctorate in medicine around 1559, after being a pupil of Gabriele Falloppia (1523-1562), successor of Colombo at the chair of anatomy and one of the most distinguished anatomists of that time.[121] After the death of Falloppia, the chair of anatomy remained vacant for about three years, during which Fabricius gave private lessons, while in 1565 he was officially appointed as professor of surgery with the duty of anatomical demonstrations. In 1600, he obtained the permanent position, namely a lifetime chair, which was a rare privilege at that time. However, in November

[118] Favaro 1921, pp. 113-114; see also: Klestinec 2004.

[119] Klestinec 2011, p. 381.

[120] Mucillo 1993, p. 34. For the biography of Fabricius, see also: Favaro 1922.

[121] Salvadori 1837, p. 11.

1563, after 50 years of teaching, Fabricius voluntarily leaved the chair for retiring to private life. The academic life of Fabricius was surely marked by great successes,[122] but also by disputes and conflicts, particularly with the Padua German Corporation of students. [123]

Vesalius and his immediate successors were principally focused on differentiating their anatomical investigations from those of Galen, so that they use animals' corpses with only two limited purposes. First, to demonstrate that Galen and his followers erroneously attributed animals' structures to the anatomy of man. Second, to overcome the limit of public anatomy, where the cadavers at disposal any year were not enough to perform a complete demonstration of human's morphology. Therefore, they used also animals, but only when a given structure was similar to the one in man. This use was performed both with dissection and vivisection, this latter becoming fundamental in Matteo Realdo Colombo's discovery (or rather, "experimental" demonstration) of pulmonary circulation. In other terms, animals' vivisection paved the way of what would later have become "*anatomia animata*", that is, physiology.[124]

Fabricius, on the contrary, fully integrated the study of animals in his anatomical research, founding what now we understand as comparative anatomy. Moreover, he further developed the study of "functions" based on the understanding of structure, so that his study of humans' and animals' morphology was always strictly correlated with "physiology". This change was due, again, to the pervasive influence of the rediscovery of classic culture. If Vesalius addressed Galen with the aim to demonstrating his mistakes and omissions, Fabricius addressed Aristotle who considered, on the contrary, a guide. As well known, Fabricius adopted an Aristotelian research program, trying to develop it and increasing its achievements.[125] In his *De formato foetu* of 1600 – considered as marking the dawn of comparative embryology – he stated: "We need both to follow and explain the theories of this great interpreter of nature, namely

[122] His medical consultations were demanded and appreciated by princes, aristocrats and ecclesiastics from all around Italy. As a surgeon, he introduced new instruments for extracting bullets and for treating fractures and dislocations.

[123] See: Favaro 1921; Klestinec 2007; Idem 2011, pp. 55-89.

[124] "*Anatomia animata*" was a definition coined by the Swiss physician and humanist Albrecht von Haller (1708-1777). See: Monti 1990.

[125] Cunningham 1985; Idem 1997, pp. 173-180.

Aristotle, who for first investigated about these mysteries. And if he missed something, we need to reveal it".[126]

Now, Aristotle's research program concerned the "animal economy". It had as object the fundamental functions of living beings such as movement, sensation, digestion, and respiration. For their understanding, Aristotle observed, dissected and possibly vivisected a multitude of animals from a wide range of taxa and reigns. His scope was to investigate similarities and differences between the structures which in different species performed the same function. But the ultimate object and scope of these investigations was the "soul". In this sense, as well explained by Andrew Cunningham: "[…] for Aristotle anatomy was completely integral to that enterprise of philosophy".[127] Fabricius adopted this same program. In the words of Cynthia Klestinec:

> Fabricius identified the Whole Animal as his object of inquiry and sought to provide a single, general, and universal account of a coordinated action or process. These processes were the vital function of the organic soul, which included motion, sensation, digestion, respiration, and generation. Where Aristotle studied the rational soul, Fabrici produced an account of speech; where Aristotle studied the motive soul, Fabrici produced a work on locomotion; where Aristotle developed his ideas on the sentitive soul, Fabrici wrote on vision and hearing; and from Aristotle's studies of the vegetative soul, Fabrici published tracts on digestion, respiration, and generation.[128]

This orientation toward functions based on Aristotle's program is perfectly clear even from both the titles of Fabricius' work and the method he followed for producing them. Starting from this latter point, Fabrici's method included 3 steps, called *historia*, *actio* and *utilitas*. With the term *historia*, Fabrici meant the moment of dissection and the description of the parts of the body. With *actio*, instead, he analyzed the way the part worked, and finally with *utilitas* he explained the objective of the function.[129] Regarding Fabricius' works titles, his *De format foetu*

[126] FABRICIUS 1600, p. 5.

[127] CUNNINGHAM 1997, p. 14.

[128] KLESTINEC 2011, p. 61.

[129] ZANATTA ET AL. 2020, p. 3.

was focused on generative function;[130] his *De visione, voce, auditu*[131] was focused on "sensitive functions"; his *De respiratione et eius instrumentis libri duo*[132] on the function of breathing; and *De motu locali animalium secundum totum, nempe de gressu in genere*[133] on the function of movement. Even this last work was directly inspired by Aristotle, who for first treated the issue of animals' movements.[134]

In the years 1570s and 1580s, anatomy was performed both at hospital and the University. In the first setting, for instance, in 1579 Marco degli Oddi and Albertino Bottoni dissected two cadavers of women died at the hospital. In the *Acta Nationis Germanicae Artistarum*,[135] the German students reported that "Toward the end of October, being the right season for anatomical dissections, Bottoni and Oddi decided to open the cadavers of the women who died in the Hospital to see with the students the place and origins of diseases".[136] As Cynthia Klestinec pointed out, these dissections were intended to be "medical anatomies", that is, autopsies focused on the understanding on the nature and cause of diseases.[137] Regarding the anatomy at the University, in 1578 Fabricius dissected human and animal corpses to connecting:

[130] As well known, Aristotle's *De generatione animalium* was the first work to provide a comprehensive theory of how generation works and an exhaustive explanation of how reproduction works in a variety of different animals.

[131] FABRICIUS 1600a.

[132] FABRICIUS 1615.

[133] FABRICIUS 1618.

[134] NUSSBAUM 1976.

[135] The *Acta Nationis Germanicae Artistarum* is a daily chronicle of University life written by the Student's German corporation of Padua between 1553 and 1769.

[136] FAVARO 1911, pp. 143-144; ZAMPIERI ET AL. 2014, p. 14.

[137] KLESTINEC 2011, p. 68. In the Latin text, "*place and origin*" (of diseases) are *locos* and *fomites*. That a disease had a *locus* means that in the body there was a "place" that was "affected". The Roman physician Celsus used *locus* in general to refer to any part of the body. In other terms, *locus* was less specific than *sedes*, which would be used, as we will see in the next paragraph, by Giovanni Battista Morgagni (1682-1771) in his seminal work, which is considered as the foundation of organ pathology. If *locus* is generically a "place," *sedes* is the place where one is "seated," where one is "homed," or has one's "basis." This means that the *sedes* of a disease was specifically the place in the body where a disease had its "home" and normally manifested. Similarly, the *fomes* (*–ites*) was originally and etymologically conceived as any type of "fuel" that alimented fire, and it passed in medicine by analogy. *Fomes* became any cause capable of alimenting the diffusion of a contagious disease, such as the clothes of infected people. Morgagni used *causa* instead of *fomes*, which means that the *sedes* of a disease was its primary cause, rather than a contributory factor. See: ZAMPIERI ET AL. 2014, pp. 14-15.

> […] anatomy and natural philosophy, studying the coordinate processes of the soul, that is, the life force responsible for motion, digestion, respiration, sensation, and generation. Fabricius's lectures and demonstrations were thus clearly distinguished on their own merits, and in the minds of students, from the medical anatomies held in the hospital of S. Francesco.[138]

In other terms, this is a further proof that Fabricius developed a new anatomy if compared to both other contemporary dissections and his predecessors at the Padua chair of anatomy.

With Fabrici, through the adoption of a new model in anatomical research, we assist to the definitive shift from descriptive to functional anatomy. Of course, it does not mean that Vesalius and the other professors in Padua before Fabrici did not investigate in functions. For instance, Vesalius made also vivisection of animals, a practice intimately connected with the understanding of what we call now physiology.[139] Matteo Realdo Colombo made the famous discovery of pulmonary circulation through both dissection and vivisection.[140] A discovery which marked another fundamental step in the emancipation from Galen. As well known, Galen postulated the existence of interventricular pores for the passage of blood from the right to the left ventricle, while Colombo demonstrated the exclusive pulmonary transit of blood.[141]

[138] Klestinec 2011, pp. 68-69.

[139] Shotwell 2015, p. 9.

[140] As well known, before Colombo also the Arab physician Ibn al-Nafis (1213-1288) and the Spanish theologian Michael Servetus (1511-1553) already described the pulmonary transit of blood in 1242 and 1553 respectively. However, Ibn al-Nafis' achievement was virtually unknown in the Western world until the beginning of the 20th century, when his work was accidentally rediscovered. See, for instance: West 1985. About Servetus, the description of pulmonary circulation was published inside a theological treatise, namely the *Christianismi restitutio*, which was considered heretical by both Catholics and Calvinists. Servetus and his books were burned at the stake in Geneva in 1553 and therefore his discovery was not divulgated. Even if it is not clear if Colombo had some knowledge of Ibn al-Nafis and Servetus descriptions, it remains that he was the first to both demonstrate and divulgate pulmonary circulation. See: Ongaro 1971.

[141] However, it is important to mention that Galen was well aware that the blood passed from the right to the left part of the heart *also* through the blood vessels of the lungs. He noticed that the widths of the vena cava and aorta exceed the widths of the pulmonary artery and vein. Therefore, not all blood entering the right heart through the vena cava could pass into the left chamber of the heart through the pulmonary vessels. He concluded, then, that some blood would have to pass through another channel between the two ventricles, which brought him to assume the existence of the invisible pores (see Siegel 1968, pp. 48-49). This rough understanding of pulmonary circulation by Galen was forgotten during the Middle Age and still nowadays it is assumed that it was discovered, independently, by Ibn-al-Nafis, Servetus and Colombo. This historical omission is even stranger if we note that William Harvey (on whom we will briefly return in a moment), in his famous *De motu cordis*, clearly acknowledged Galen for having described the pulmonary transit of blood: Harvey 1628, p. 38.

The shift toward functional anatomy is appreciable also in the new way in which Fabricius realized anatomical illustrations, which was furtherly developed by his famous student William Harvey (1578-1657), universally known for the discovery of systemic circulation. To enhance the teaching and learning of anatomy, Fabrici realized the importance of the "dimension" and "colour" of anatomical illustrations. In Vesalius, for example, the images were neither full-scale nor had the natural colour, being in black and white. Fabrici enriched his works with a huge iconographic project which consisted of two types of images, the *dissegni* (drawings) and the *pitture* (paintings). The formers were "classic" black and white illustrations, while the latter were coloured full-scale painted plates. All this iconography was to become part of the *Theatrum totius animalis fabricae*, a titanic atlas of the entire
human and animal anatomy he never achieved.[142] Fabrici considered the *Theatrum* as the theoretical counterpart of the anatomical theatre that he contributed to realize at the University of Padua.

Fabrici's illustrations have two significant features indicating his attempt to "describe" animal and human functions, and to "represent" them. First, he introduced full-scale and colour painted plates. In this way, the images were closer to representing "living" parts, than previous black and white and low scale images produced by Vesalius. Second, Fabrici was one of the first scholars to create an "anatomo-physiological" image, namely the one representing the valves in the veins in his *De venarum ostiolis* (Fig. 2.1).[143] This image, in fact, shows the "physiological" enlargement of veins and the consequent appearance of the valves when the forearm is tied above the elbow. As well known, Fabricius did not understood the proper function of the valves. He interpreted their function within the Galenic system, according to which the blood unidirectionally flowed from the heart to the periphery. Therefore, Fabricius advanced that the valves served to slowing down the venous blood coming from the heart and di-

[142] See: Rippa Bonati & Pardo-Tomàs 2004.

[143] Fabricius 1603; Zanatta et al. 2020.

rected to the periphery and to facilitate the perfusion of collateral veins from the principal ones.

William Harvey first understood the proper function of the valves of veins. He interpreted these valves, with the demonstration of blood circulation. As himself told in his *Lumleian Lecture* given to the College of Physicians of London in 1616:

> At the age of 19, I enrolled in the respected medical school at Padua, that great Italian centre founded in 1222, where Vesalius, Columbus, Cesalpino and Galileo taught so well. My professor was Fabricius d'Acquapendente, whose interest in the venous valves so stimulated my conclusions to be set forward today.[144]

Harvey spent two years in Padua, graduating in 1602.[145] Then he went back to England, establishing in London, where immediately he became a member of the *Royal College of Physicians*, which required a difficult exam finally accomplished by Harvey in 1607. He then worked at the London St. Bartholomew's Hospital, where he spent almost all his carrier. His fame gradually grown, up to being elected as *Physician Extraordinary* to King James I (1566–1625) in 1618 and *Physician in Ordinary* to Charles I of England (1600-1649) in 1632. The Civil War obliged the king to retired in Oxford, followed by Harvey who became head of the Oxford Merton College in 1645. In the same year, however, he came back to London, where he retired from work and public duties, dying in 1657. As well known, during his life Harvey published two works. The first, entitled *Excertitatio anatomica de motu cordis et sanguinis in animalibus*,[146] marked a crucial moment in the history of medicine, because with this book he demonstrated blood systemic circulation. In the second, entitled *Exercitationes de generatione animalium*,[147] he gave an important contribution to embryology.

The titles of these works clearly indicated Harvey's debt to Fabricius and his Aristotelian project.[148] Harvey did not treat only human anatomy, but he aimed at studying all the "animals" in a comparative way. Moreover, he was not focused only on structure, but also on function: the first work, in fact, regards the "movement" of the heart, while the second concerns the "generation".

A crucial moment for Harvey's discovery of blood circulation was when he was elected to the *Lumleian lectureship* in the *College of Physicians* in 1615. He made detailed preparations for his course of lectures and the surviving notes further confirms that two things were important in Harvey's approach to the heart. First, his notion of anatomy was the Aristotelian knowledge of a part of the body as a requisite to understand its function. Second, as a pupil of Fabricius in Padua he saw that the function could be understood most clearly in a range of different animals.

Whatever the heart belongs, characteristic and identifying action must be present in all cases.[149] Thanks to the studying the heart of the animals, Harvey could understand the circulation of the blood. In fish, for example, which have only one atrium and one ventricle, it is much easier and more immediate to see that the blood passes from the veins to the arteries. In man, the presence of two atria and two ventricles, separated by septa, have brought ancient physicians to think about two systems (venous and arterial) that remain functionally separate. But this was not the case, as Harvey showed they are in series not in parallel. It might be worth mentioning that Harvey finally demonstrated systemic circulation also by calculating the left ventricular blood output [1].

Another proof of Harvey's debt to Fabricius is given by the only illustration published in his *De motu cordis*, which closely resembles to that of Fabrici (Fig. 2.2). In a passage of the manuscript of the *Lumleian lecture* of 1616, Harvey stated that the simple experiment of using a tourniquet to visualize the valves was the first demonstration of the "perpetuum sanguinis motum in circula ab arteriis ad venas".[150]

However, whereas Fabrici viewed the valves' function with Galenic eyes, Harvey reinterpreted them as tiny one-way gates ensuring that blood would return from the veins to the heart to be recirculated through the arteries. In his *De motu cordis*, Harvey wrote that:

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144 Silverman 2007, p. 201.

145 French 2002; Ongaro et al. 2006; Marrone et al. 2016.

146 Harvey 1628.

147 Harvey 1651.

148 Pagel 1976, pp. 13-33; Fara 2007.

149 French 2004.

150 For an intestersting account of the early account of the valves in the veins, see: Leibowitz 1957.

> The illustrious Girolamo Fabrici d'Acquapendente [...] was the first to depict membranous valves [...] The discoverer did not understand the exact function of these valves, and nothing has been added by others. In reality, their function is not to prevent all the blood from falling down to the lower parts [...] But without doubt the valves were made so that the blood [...] proceeded [...] from the most distant parts towards the centre: so the thin valves easily they open to this movement, while they completely stop the opposite movement.[151]

It might be interesting to note that also Gaspard Bauhin (1560-1624) played an important role in Harvey's studies.[152] Bauhin was the most cited author, after Vesalius and Fabrici, in Harvey's work. And it was Bauhin's work that Harvey chose as the basis for his *Lumleian Lectures* to the *College of Physicians* in London in 1616, basically because the Swiss anatomist offered to him many examples of "valves" in the body which were unidirectional structures preventing reflux.[153] The step further made by Harvey is indisputable also analysing the diagram in *De motu cordis* inspired by that of Fabrici. Even Harvey's illustration has an "anatomo-physiological" function, representing a definitive demonstration of the direction of venous blood and the anti-reflux function of the valves (Fig. 2.2). The first picture, on the top, is identical to those of Fabrici: it shows the "physiological" enlargement of veins and the consequent appearance of the valves when the forearm is tied above the elbow. In the second picture, above the first one, a hand pointing the vein clearly shows veins swelling distal to the ligature, which prevent blood returning to the heart.[154] In the third and fourth drawing of Fig. 2.2, another hand compresses the vein from a valve downward, letting show that the blood does not move backward, because of the valve. This was an experimental demonstration, illustrated by a convincing picture, of the direction of blood, function of valves and blood circulation. The school of Padua based on anatomical demonstration with illustrations, was developed and exalted by this emblematic "powerful image", which

[151] Harvey 1628, p. 41.

[152] Born in Basle, Bauhin studied medicine at Padua, Montpellier and then in Germany. He came back to Basle around 1580 and few years later, he started a brilliant carrier at the local University.

[153] French 1994, pp. 358-360.

[154] French 1978, p. 720.

paved the way to modern physiology and pathology, and gradually revolutionized the whole medical theory and practice.

Conclusion

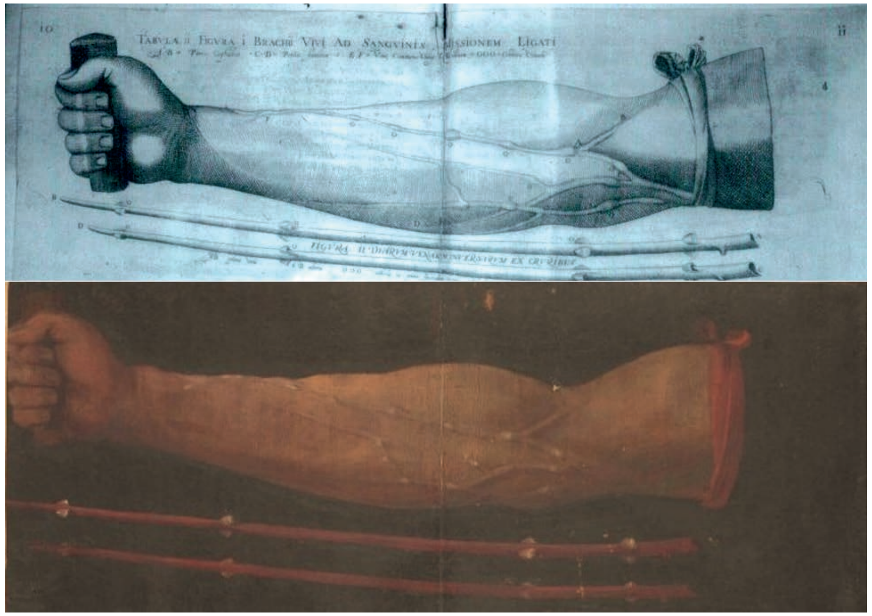
The extraordinary achievement of the sixteenth and seventeenth centuries, represented in particular – but not only – by studies in human anatomy and "physiology", paved the way to what that might be considered the "last" golden age of the university of Padua, the eigthteenth century. At the really beginning of the century, for instance, Bernardino Ramazzini (1633-1714) and Antonio Vallinsneri (1661-1730) were called at the chairs of "practical medicine". Ramazzini is universally known as the father of occupational medicine, thanks to his *De morbis artificum diatriba* in which, for first, he tried to correlate the condition of workers with their diseases.[155] Vallisneri was a physician and naturalist who established epistolary relationships with the most representative figures of the new sciences all around Europe.[156] The most important figure of that time was Giovanni Battista Morgagni (1682-1771), who contributed to the definitive decline of humoral pathology establishing a systematic correlation between clinical symptoms in living patients and organic lesions found at autopsy.[157] His *De sedibus et causis morborum per anatomen indagatis* can be considered the dawn of organ pathology and the beginning of a new way of medical diagnosis.

The fall of the Republic of Venice and the French and Austrian dominations of Northern Italy determined a partial decline of the University of Padua and its medical school in the nineteenth century. Yet, it still is an important centre and one of the leading medical schools in the world.

[155] Ramazzini 1700.

[156] Generali 2004.

[157] Zampieri 2016.



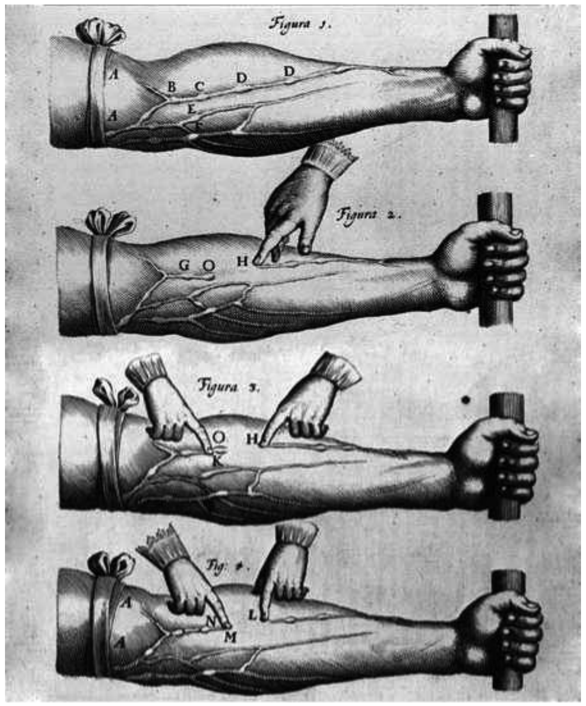


Fig. 2.1 - Fabrici's valves of the veins. On the top, the image published in the De venarum ostiolis. On the bottom, the image painted in the *Theatrum totius animalis fabricae.*

Fig. 2.2 - Image from Harvey's *De motu cordis* inspired by that of Fabrici. Harvey's illustration represents a "visual" demonstration of the direction of venous blood and the anti-reflux function of the valves.

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THE ANATOMY THEATER: TOWARDS A PERFORMATIVE HISTORY

Introduction

Anatomy theaters are locations designated for the study of anatomy where, during the early modern period, people learned about human anatomy through the dissection of cadavers, the dissection and vivisection of animals, the display of articulated skeletons and preserved skins, and the study of drawings and printed illustrations.[1] With these materials, anatomy theaters framed various pedagogical goals and means of edification. An anatomist could focus on the structure of parts or their functions (actions and uses); or he could limit his study to specific regions of the body, especially if some parts of the cadaver had deteriorated or gone missing; or, conversely, he could provide a comprehensive introduction of the entire human body, or 'the animal' in general. These possibilities, which could be extended, all took place in the anatomy theater at one time or another; some demonstrations were investigative and exploratory, others introductory. Though it might be tempting to imagine a teleology whereby these locations eventually became ideal places for seeing, as the Latin *theatrum* would suggest, the various pedagogical goals and logistics of the theater tell a different story, one in which the purpose of the theater is not centered on seeing and display.

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[1] Scholarship on these matters is too vast to list here. Two recent contributions to it include studies of how illustrations were used in anatomy instruction: Kusukawa 2012 and Allen Shotwell 2016.

DOI 10.48255/M.9788891320186.03

Anatomy demonstrations were held within temporary and permanent anatomy theaters; and these demonstrations were consistently called public (in contrast to private lessons). They were conceived as instruction to students who were studying medicine and who had matriculated for some years, an audience larger than the number of students enrolled in a single course. Although the audience would include primarily medical students and university administrators, it could be extended by the presence of local and regional officials. The public demonstrations at the University of Padua were sometimes attended by the *riformatori*, (usually) three official liasons between the government of Venice and its university. With its public designation and the growing interest in the study of anatomy, the anatomy theater was often overcrowded, and its demonstrations interrupted. For this reason, regulation is a critical theme that can be found in most discussions of the anatomy theater per se.

What difference did it make if the anatomy demonstration took place in a theater rather than the back room of a pharmacy, in a hospital, or in the private chambers of a professor? This essay argues that while there are many historical changes to document in the study of anatomy and in the form and content of the anatomy demonstration, the anatomy theater played a signficant regulatory role in the educational and cultural history of anatomy. Ideas about the regulatory power of the anatomy theater are present from the earliest debates on how demonstrations of anatomy should proceed. These debates continued throughout the early modern period when protocols were often implicit, ritualized, or dependent on the specific goal of a particular demonstration. The term protocol is a familiar one, taken from the sciences and treated critically in science studies, the history of science, and the history of medicine, where its modern sense tends to signal experiments and experimentation, clear designs, often hypotheses, and narrowly construed methods. The anatomy theater was designated for the study of anatomy, but the protocols for that study varied considerably and changed over time. They were shaped in part by materials such as statutes: civil statutes regulating the use of cadavers as well as university statutes regulating attendance and behavior. Although statutes were relatively stable and consistent across geographical domains, they were qualified by the participants, some of whom failed to follow even the most ritualized of protocols. Read against the grain of an enduring archive of regulatory statutes, that variation provides clues to a performative history of the anatomy theater.

Using regulatory statutes and decrees as well as descriptions of particular anatomy demonstrations in northern Italy, this essay reconstructs a performative history that emphasizes the anatomy theater as a site of control, regulation, and for the audience, especially medical students, compliance. Even when the theater failed, it was conceived and continued to be treated as a regulatory device. The theater received university and civic support, including financial resources, so that it might "better" control the proceedings; anatomists were placed in positions of authority through the regulatory regime of the theater; students were expected to behave in the theater—maintain silence, a sense of modesty, and ultimately submit to professiorial authority—which in turn colored their perceptions of anatomy and what it meant to study it; and all of this contributed to a sense that the study of anatomy was necessary and culturally permissable.

Although the anatomy theater housed demonstrations of Galenic anatomy for some 200 years, the demonstrations were not mere repetitions. A full account of the anatomy theater requires an understanding of the changing substance of the demonstrations and methods of inquiry as well as the changing nature of the performance. In her seminal work on performance theory, Diana Taylor suggests that performance histories should include both the archive—identified with permanence and a resistance to change—and the repertoire. The repertoire refers to embodied practices, with an emphasis on gestures, orality, individuation and even idiosyncacy, those features that are usually seen as ephemeral, nonreproducible: "the archive and the repertoire exist in a constant state of interaction [even though] the tendency has been to banish the repertoire to the past."[2] Embodied performances, she continues, have played a central role in "conserving memory and consolidating identities in literate, semiliterate, and digital societies. Not everyone comes to 'culture' or modernity through writing."[3] While most of the audiences at anatomy demonstrations were literate, the anatomy theater was a site for encountering anatomy, and the archival and embodied performances of anatomy had histories. The performances inside the anatomy theater reflected the hierarchies of authority at the university, consolidating the identities of professors of anatomy and their students in the pursuit of

2 Taylor 2003, pp. 19-20.

3 Ivi, p. xviii.

anatomical knowledge, a pursuit that was inextricable from the forces and forms of regulation that the theater heralded.

Statutes and early anatomy theaters

Anatomy demonstrations were routinely held during the coldest months of the year, usually January and February, and often during the break between semesters. They were attended by medical students as well as local and regional officials. For much of the early history of anatomy demonstrations, these demonstrations focus on the dissection of one to two cadavers, who were executed criminals. In Padua, the statutes also state that the cadaver must be foreign, an addition that suggests the culture's unease with human dissection.[4] The local community associated the annual anatomy demonstration with disrupted burial ceremonies; the process of dissection forced the burial to be altered. Moreover, as Katharine Park has shown, there were additional concerns around burial, namely that the practice of dissection raised fears that local rather than foreign bodies were being used; these were the poorest of the poor for whom proper burial could not be ensured.[5]

At the university, statutes further stipulate that the typical public anatomy demonstration was organized by the rector and two *consiliarii* as well as two senior medical students called *massarii* (mace-bearers) who were responsible for setting up the event.[6] The two medical students, elected through their affiliation with student nations, were re-

[4] *Statuta almae universitatis d. artistarum et medicorum patavini gymnasii* (Padua: Innocentium Ulmum, 1570), 36, Archivio antico università di Padova (AAUP), Padua, Italy. In Venice, the Senate confirmed the practice of anatomical study in the statutes of the medical college in 1507. This confirmation suggests the existence of a tradition of demonstration, one superior to the exercises of anatomy in Venice as "secundum legum et consuetudinem antiquam." Jerome Bylebyl notes that "the Venetian statute dates back at least to 1368, when the Venetian government ordered the College of Surgeons to conduct an anatomy at least once a year, which all physicians and surgeons of the city were required to attend, and to 1370, when it ordered the physicians to share equally in the expenses." See Bylebyl 1990, pp. 285-316, esp. 311. See also Nardi & Musatti 1897, p. 6; Tosoni 1844, pp. 103-104. For a discussion of the organization as it is reflected in the iconography of anatomy scenes, see Carlino 1999, pp. 8-68. This study was originally published as *La fabbrica del corpo: Libri e dissezione nel Rinascimento* (Turin: Einaudi, 1994).

[5] On the illicit means by which cadavers were obtained, see Park 1994, pp. 1-33.

[6] See note 2.

sponsible for gathering the instruments and procuring the cadavers through official channels.[7] Student nations were demographically specific; when a student came to the university, he would matriculate into the nation that represented his geographical place of origin.[8]

According to the statutes, the anatomy demonstration would take place in the winter months and last up to 6 weeks. During the demonstration, the *lector* recited passages from a text such as the first *fen* of Avicenna's *Canon*, Galen's *De usu partium corporis humani* or Mondino's *Anatomia* (1316, Mondino dei Luzzi, Mundinus, d. 1326); the *demonstrator* or *ostensor*, frequently translating that material from Latin into the vernacular, indicated to the dissector or *incisor* the parts of the body that should be dissected.[9] According to the 1545 statutes for Padua, the dissection would follow a lecture and reading of the *Anothomia* (1316) of Mondino, a dissecting manual that draws on the anatomical studies of Galen as well as the medieval scholastic tradition of anatomizing.[10] The statutes propose two sources of authority: the *lector*, who channeled the knowledge of the text, and the *demonstrator*, who was supposed to "verify" that knowledge in the cadaver. The statutes thus made the body illustrate and confirm the text.[11] In Mondino's *Anothomia*, a well-known illustration depicts the cadaver surrounded by a few medical students, and above them, the professor stands behind his podium, his *cattedra*, lecturing from a book while an *ostensor* 'shows' the dissector where to cut. The scene renders order visually with the professor placed above his associates and students; and it endows both the professor and the book with authority.[12]

The statutes organized the demonstration but also constrained it. As R. Allen Shotwell has recently explained, anatomists understood, complained about, and found ways to address the limitations of the 'single

[7] On the licit means of acquring cadavers, see Carlino 1999, pp. 77-91.

[8] On the student nations in Bologna and Padua, see Kibre 1948, pp. 3-64, 116-122; and Brugi 1905.

[9] The dissector could have been a barber, a surgeon, a graduate surgeon, or a student. On the format, see Carlino 1999, pp. 11-12.

[10] See: Giorgi & Pasini 1992; Singer 1925.

[11] *Statuta almae universitatis d. artistarum et medicorum patavini gymnasii*, 36.

[12] On the inertia of the textual tradition, see Carlino 1999; and for an analysis of the anatomist's gaze as mediating the confrontation between book and body, see Mandressi 2006.

body' demonstrations.[13] For example, Vesalius brought articulated skeletons to the theater; and he and other anatomists dissected and vivisected animals to compare and enrich the study of human anatomy. The tension between an anatomist's pedagogical goals and the statutes was often productive. In a temporary theater at the University of Bologna in 1540, Matthaeus Curtius provided the lectures on Mondino's text while the younger anatomist, Andreas Vesalius provided the dissections. The Silesian student, Baldasar Heseler attended both parts of the anatomy demonstration, and his notes indicate that Vesalius repeatedly undermined the authority of Curtius (as well as that of the text).

This demonstration was held in a temporary anatomy theater in which pedogogical goals and logistics were fraught. During one of his demonstrations, Vesalius vivisected a dog in order to show that when the *nervi reversi* (the recurrent laryngeal nerves) were severed, the animal would cease to bark. He then described the relationship between the movement of the heart and the pulse of the arteries. Heseler wrote: "I myself saw how the heart of the dog bounded upwards; and when it no longer moved and the dog instantly died. Those mad Italians pulled the dog back and forth so that nobody could truly feel those two movements."[14] When the students asked Vesalius what he thought about these movements, he replied: "I do not want to give my opinion, you yourselves should feel with your own hands, and trust them."[15] The example illustrates Vesalius' pedagogical tendency, even if it was an outer limit of that pedagogy, to "feel with your own hands." As many scholars have noted, Vesalius cultivated a pedagogy that encouraged students to challenge authority just as he, the young instructor, challenged the authority of Curtius.[16] The scene poses the destructive Italian students against their quiet, earnest transalpine colleagues. The scene presents the problem of touch and how the right kind of touch—one that applies pressure without destroying the object, one that is sensitive to motion and perhaps heat—might be developed (in transalpine hands, moreover). The performative history of this anatomy theater reflects the authority of the professor, a point well established by scholars, and also the posture and habits of a good medical student.

[13] Shotwell 2015.

[14] Eriksson 1959, pp. 290-93.

[15] Ivi, p. 292-93.

[16] See O'Malley 1964; and T. Persaud's writings for multiple examples.

In Padua, the idea of good medical students continued to involve the transalpine students, who were devoted to the study of anatomy, and the anatomists who supported them. In 1556, Gabriele Falloppio (1523-1562) wrote a letter to the *Riformatori dello Studio*, Venetian magistrates, to request support for the annual anatomy demonstration.[17] In the letter, he highlighted the eagerness of the students, especially the German and Polish students, for a public anatomy demonstration; he speculated that if preparations—including a temporary construction—for the annual demonstration were not soon and evidently underway, these students would leave the university for either Bologna or Ferrara, where such spectacles [*feste*] were regularly held: "I go to them [these eager students], detaining them with many promises that without doubt, during this break, we will have an anatomy. But I do not know if they will wait for it if I am not helped by you [the *riformatori*]."[18] He asked the *Riformatori* to write a letter to the *Podesta* (a city official) in order to expedite the acquisition of cadavers.[19] The letter acknowledges the official, licit use of cadavers; it also presents the professor as extremely concerned about these students, engaging them rather than isolating himself from them; and finally, the letter reflects the eagerness or commitment of the transalpine medical students, a commitment to the study of anatomy that superceded their institutional affiliation.

[17] Gabriele Falloppio took the chair in surgery, simples and anatomy in 1551. For more on Falloppio, the standard biography remains: Favaro 1928.

[18] The original letter is held in the Archivio di Stato, Venice (ASV), *Lettere dei Riformatori dello studio*, 1555-1559, filza 63. It was published in Favaro 1928, p. 227, and again in Di Pietro 1970, pp. 29-30. The ellipsis indicate a corrupted text: "[...] gli tempi serenissimi aggiuntavi la neve, et il …chio, colle vacanze di Natale che vengono invitano all'anatomia, et dopiano l'ardore immenso de scolari, gli quali essendo stato due anni senza, non veggono l'hora che si venga a mostrargli la fabrica humana: Qua sono molti scolari Thedeschi et Poloni, gli quali non vedendo preparamento alcuno, et dubitando quasi che non si faccia per diffetto di soggietto, s'incominciano d'apparecchiare per andare a Bologna o a Ferrara, dove indubitatamente l'havranno queste feste. Io gli vado tratenendo con buone promesse, et che senza fallo in queste vacanze havremmo l'anatomia; ma non so poi come attendergli se non sono aiutato dalle Ill. Me Mag V". On 7 December 1556, he sent a letter to the rectors of Padua, recommending anatomical specimens be procured. On 15 December 1556, the *Riformatori* wrote to the *Podesta* to request anatomical specimens, and approximately two weeks later, the specimens were obtained.

[19] Favaro 1928, p. 227: "Però prego quelle riverentemente, che voglino scrivere una sua al clar.mo Podestà et raccommandargli l'anatomia chiedendogli un soggietto quanto più presto sarà possibile, o con … a gli Massari dell'Anatomia, che essi segretamente se ne passano procacciare uno quando gli venga l'occasione di person ignobile et non conosciuta".

In the mid-sixteenth century, temporary theaters housed these anatomy demonstrations, and this instruction fell within the jurisdiction, so to speak, of the university. Throughout the early modern period, the instruction that professors gave at the university was scrutinzed. In Padua, perhaps because of its perceived distance from the Church, university officials kept careful watch over teaching, emphasizing that professors should not deviate from orthodox methods and opinions. In the statutes of the medical faculty at Padua in 1570, the teachers were warned not to present views opposed to those in the prescribed texts, and they were urged to expound the texts according to recognized authorities.[20] Anatomy theaters and the knowledge produced within them were inextricable from more pervasive concerns about orthodoxy and compliance.

One might contrast this conformity to the historiography of the Scientific Revolution, which has tended to privlege novelty and align it with subversive and iconoclastic tendencies. The anatomy theater in Bologna, for example, has been described as subversive because of its connections to Carnival, with its rituals of inverting power structures. And yet, such associations were not prominent until the eighteenth century.[21] Although anatomy theaters incorporated observation and investigation, and as time wore on, their exploratory functions were streamlined, such developments were not predicated on subversion and iconoclasm (though Vesalius is often singled out as a key figure in this respect). For the early modern period, the anatomy theater was a site of regulation and compliance.

Anatomy theaters: Regulatory measures and tranquility

Differences between temporary and permanent anatomy theaters are difficult to assess in part because archival sources for temporary theaters are scarce. But one tendency that marks the transition from temporary

[20] The phrase is: "legere & clare exponere ac declarare textus authorum quos legere tenentur de verbo ad verbum neque amplius aliquem expositorem sive commentatorem Galenoo excepto". See *Statuta almae universitatis d. artistarum et medicorum Patavini gymnasii. Denuo correcta et emendata existente Rectore mag. D. Aleysio Scloppo veron*. Patavii, 1570. Denuo aucta, emendata & in 4. Lib. digesta, Patavij, 1648. This regulation was repeated in the Statuta of 1648" (Eriksson 1959, p. 41).

[21] See Giovanni Ferrari's groundbreaking article on the Bologna theater.

to permanent theater is a more explicit approach to regulation, as the case of Padua's theaters demonstrates. The university archives in Padua indicate that there were two permanent anatomy theaters, built consecutively. The second one, which still exists, was completed in 1595. The earlier one, completed by 9 January 1584, was "built in the best lecture hall at the expense of the Venetian Senate". Both theaters were intended to house orderly demonstrations, and in different ways, both were compromised. Overcrowding continued; students frequently interrupted professors; instruments were stolen, cadaverous parts were destroyed.

In the 1580s, there were two decrees that were intended to address these problems and to bring, in the words of a slightly later commentator, "tranquility" to the anatomy theater. The first decree mandated that students were supposed to listen quietly or be excluded; that the procession into the theater would be lead by the rector, who would be followed by professors and then the students; and that no student could sit in the first row without incurring a fine. Here we find the outlines of the performance of a Galenic anatomy demonstration, a script with stage notes for all the participants – rector, anatomist, other professors, students – that clarifies the order and hierarchy of the event and by extension, of the university.

The second decree stated that prior to the demonstration, students had to attend preparatory lectures. This decree suggests that the two parts of the anatomy demonstration – lectures and demonstrations – were part of a unified experience; the decree underlined that unity perhaps to distance the proceedings from the execution of the criminal whose body was its subject. The statutes clarify this, but the decree, rather than acknowledge the execution as part of the "preparation" of the event, emphasizes the anatomy events – both lectures and demonstrations – as university events, enforcing a sharp boundary between the city and the university, the civic ritual of execution and the academic ritual of dissection. Scholars have speculated on the extent to which anatomy demonstrations were continuations of the punitive nature of executions, colored by their associations with the discipline and punishment of criminality in the early modern period. One reason it may be difficult to detect the punitive, disciplinary elements within the anatomy theater is because the theater was an academic space and its exercises were explicitly demarcated from civil forms of punishment, as the nature of this decree suggests.

While these measures were not entirely effective, the failures that ensued tell us more about the ways that the anatomy theater brought the academic community together and, at the same time, clarified or perhaps strengthened the hierarchies within that community. This can be seen in the example of the anatomy demonstration of 1588-1589.[22] On 23 January 1588, seven days into the demonstration, which took place in the first permanent anatomy theater, the anatomist began his afternoon lecture on the topic of generation and the formation of the fetus in utero (a topic obviously not tightly linked to the male corpses on view); but he was interrupted, for the theater was "besieged by many people, friends of the student-assistants [*massariorum amicis*] and members of the local community [*popularibus*]."[23] The overcrowding was described in terms of noise and confusion. It also lead to seating problems (no one was seated, but they stood in particular zones in the theater). The Beadle tried to handle the latecomers and especially the Syndic (a university-educated man who served as a legal overseer and sometimes secretary for the rector).[24] The Syndic could not make it to his usual seat near the doctors and professors and had tried to stand with the student presidents of the university; the Beadle ordered the *assistants* to give him a place. The theater failed to organize the audience, to render with any degree of clarity, the hierarchies that were meaningful at this university.

[22] FAVARO 1911-1912, vol. 1, p. 266 and following. The students were Urbano Zussnero Carniolano and Eberhardo Vorstio Geldro Ruramondano, lead counsels for the transalpine nation. And, *Acta*, 1588-1589, vol. 1, 267: "Ad ultimum Massarii etiam admoniti fuerunt, ut diligenter observarent, me loca illa, quae Consiliariis in anatomia destinata sunt, ab aliis occuparentur, atque illi vel abire vel de alio sibi loco prospicere cogerentur. XIIII die eiusdem mensis a magnifico huius urbis magistratu duo hominum propter furta et maleficia perpetrata ad furcam damnati sunt; et quo minus anatomia publica impediretur aut differeretur, istorum corpora eadem statim die Universitati concessa fuere.

[23] *Acta*, 1588-1589, vol. 1, 267-268: "Anatomicus audita iam hora lectionis initium fecisset, loca illa, quae tantum pro Consiliariis retinenda essent, a pluribus aliis vel Massariorum amicis vel popularibus obsiderentur, ut ita advenienti Domino Syndico apud Consiliarios nullus relinqueretur locus... Syndicus autem Universitatis atque amplissimi sui offitii ratione statim ab initio anatomiae apud Doctores et Professores in theatro locum obtinere potuerat; ne se ipsum tamen ingerere videretur, Dominis Consiliariis se adiungere maluit. Cum igitur se aliquantulum tardius accessisse, atque loca, facto lectionis initio, replete videret, potius sibi abeundum quam strepitum aliquem excitandum aut legentem Anatomicum interturbandum esse, cogitavit". On class categories, see PULLAN 1971.

[24] DE RIDDER-SYMOENS 1996, p. 173.

As the scene continued to deteriorate, the focus turned to the students. Two of the *assistants* who happened to be Sicilian stopped the show. The transalpine student writing the account said he "might more accurately say, two assassins," but they were students.[25] These Sicilians neglected "the authority of the entire university and the most excellent who were present" by interrupting the event and threatening the spectators.[26] Amidst "hisses and disgraceful words [*sibilis et ignominiosis verbis*]," a fight broke out; and the anatomist earnestly forbade the Sicilians to undertake anything further against the Syndic.[27] The anatomist, that is, used his authority to protect the Syndic. In the end, the Sicilian thugs were removed from the theater, which was destroyed sometime between 1589 and 1591.[28]

From this episode, the problems of regulation emerge prominently. The theater was intended to house a large audience, one that reflected the diversity of the academic community, both its horizontal relations (between students) – note the way that the transalpine students referred to their Sicilian classmates as assassins – and its vertical relations (flowing from professor, rector, and syndic to the assistants and the presidents of student nations). This community became disordered in literal and symbolic terms. Indeed, following this conflict, officials wonderered if, in the future, some students should be better armed so that they would be able to resist violent adversaries. Meanwhile the transalpine students worried that they had offended the anatomist, who might have mistaken

[25] *Acta*, 1588-1589, vol. 1, 268: "Sed bidellus Universitatis, qui ad theatrum expectare atque advenientes Professores ad assignatas sessiones deducere soelabt, videns in theatro quaedam Professorum loca vacua superesse, Domino Syndico locum dari Massarios iubet...Etenim Domino Syndico vix theatri limina transgresso, duo Siculorum, seu ut rectius dicam siccariorium, ex quatuor illis Massariis obviam fiunt, qui non solum posthabita omni Universitatis et praesentium Excellentissimorum virorum authoritate, sibilis et ignominiosis verbis ipsum ut hoc loco indignum explodere tentabant, sed etiam alter ipsorum exuto omnis humanitatis offitio, stricto pugione impetere nequaquam subverebatur".

[26] IBIDEM.

[27] IBIDEM: "Contra tamen Dominus Sapiens, ut vere sapientem atque fortem virum decet, sufficienter refutatis atque convitiis in adversaries retorsis, strenue se opposuit, neque latum quidem unguem ab eo quem occuparat loco dimoveri passus fuit. Ubi Anatomicus intelligeret, rem hanc ad arma devenire, atque hunc ignem in immensum incendium quod postmodum quam difficillime consopiretur, excrescere et hinc propter vicinum malum ad se quoque aliquid mali pervenire posse, confestim Siculis serio interdixit, ne quid ulterius contra Syndicum, cui maxime hic locus competeret, susciperent".

[28] See GAMBA 1986-1987, pp. 157-61, pt. 3.

their friends as the cause of the disruption and then held their nation at fault. These consequences were displayed after the fact, but they register the crucial importance of order within the theater and the regulatory role of the theatre itself.

An additional observation might be made about this episode. In the moment of the conflict, during the performance, the Syndic had entered late, and unable to take his usual place, he went to stand with the presidents of the student nations. When the Sicilian students obstructed his passage, the Syndic opposed them. The transalpine students, who described the episode in their notes, wrote that the Syndic "did not suffer himself to be moved from the place which he occupied even by the breath of a fingernail [*neque latum quidem unguem*]." We would understand the breadth of a fingernail as a spatial description, but the sources for the phrase – one was Plautian comedy and the other was the Bible – indicate that it can be an argumentative position as well, where the sense of the phrase conveys an unwillingness to fall away from the object of devotion.[29] Here, the performative history of anatomy includes not only the display of the professor's authority in concert with books and bodies but also the rehearsal of commitment, an embodied element that was powerful enough to draw the attention of these transalpine students, who sought the unusual Latin phrase to express the nature of the Syndic's devotion. His devotion was not only to anatomy but also to the theater, whose regulatory force gave shape to his commitment.

The theater's regulatory functions could be enhanced in sometimes surprising ways. In 1589, in Padua's first anatomical theater, the anatomist gave an anatomy demonstration that began with a dissection of the "muscles related to speech" and the organs "serving pronunciation." Digressing from the main line of his demonstration, he paused to connect the subject matter to his particular audience of students. These students hailed from the Venetian Republic and elsewhere on the Italian peninsula and from across the alps. A transalpine student described the scene:

[29] For example, see Plautus, *Aulularia* I.i.18; and on the biblical sense, Edward Campion cites "quia nos ne latum quidem unguem discedimus a verbo Dei" in *Ten Reasons Proposed to His Adversaries for Disputation in the Name of the Faith and Presented to the Illustrious Members of Our Universities* (n.l.: Cosmopoli, 1581), 228. I thank Evan Hayes for these.

> [the anatomist] began on this occasion of his sermon to ridicule the pronunciation [of Latin] of various [student] nations. In the midst he arrived at our praiseworthy nation, saying, "the pronunciation of the transalpines is hard and slow, since indeed they wish to pronounce [words] while they compress the mouth excessively—this would be the cause—so that always they pronounce awkwardly the *f* for the *v*," and for the record, he began to demonstrate the words: qui *p*onum *f*inum *p*ipit, *t*iu *fi*fit.[30]

Imitating the speech of the transalpines, the anatomist meant "qui bonum vinum bibit diu vivit," *he who drinks wine lives a long time*. The students found his joke, that they slurred their speech and spoke like "drunkards [*insignis vini potatores*]," humiliating.[31] By their account, he put forth these words "ad nauseam," and "he felt great joy from these words so much repeated that he was unable to contain his own laughter."[32] Although the anatomist eventually brought himself and the scene to order, the transalpine students felt "exposed" "in the presence of all the other nations."[33] The joke had called attention to the transalpine students as foreigners, flagging their status as linguistic, demographic and because their Protestant leanings were assumed, religious outsiders.

Not a grammar lesson at all, the scene captures the less obvious or explicit functions of the anatomy theater: its ability to configure and recognize the social relations of the students and their professor; and its ability to connect anatomical themes quite directly to issues of both classical education (Latinity) and civility (the manner of speaking). The the-

[30] *Acta*, 1589, vol. 1, 269: "Nam in anatomes lectione publica, cum in dissectione musculorum linguae illarumque partium voci atque pronunciationi servientium versaretur, occasione hinc incepta sermonem satis tamen ridiculum de variarum Nationum pronunciatione habere coepit. Inter caeteras autem praemissas Nationes, ad laudatissimam quoque nostram devenit, dicens: Germanos durae atque tardae pronunciationis esse, siquidem os nimium, cum pronunciare vellent comprimerent, quod in causa esset, ut semper inepte literam f pro v pronunciarent, uti hisce annalibus verbis id demonstrare conatus fuit: qui ponum finum pipit, tiu fifit".

[31] Ibidem: "Haec verba peroptime huic rei quadrare videns, non unica atque altera, sed crebrius et ad nauseam usque protulit, atque ex istorum verborum repetitione huiusmodi voluptatem persensit, ut risum simul cohibere non posset, quasi vero Aquapendenti alia verba defecissent, quibus modestius, si quod virum loquelae nostrae dicendum adsit, corrigere potuisset. Sed hinc facile coniiendum, id praemeditato studio factum fuisse, quo nos Germanos, ut insignes vini potatores, in tot Nationum praesentia ludibrio atque risui exponeret".

[32] Ibidem.

[33] Ibidem.

ater was a new space in the institutional landscape of the university. It was regulated by university statutes; and anatomists made adjustments for it that were pedagogical and logistical. But here, the theater allowed the anatomist to target foreign students, emphasize their different speech patterns, and remind all of the students that a connection to the ancients was both important and something more easily achieved by southern Europeans, especially Italians. Italians spoke Latin in the right way.

The scene, though comical, encourages us to consider the regulatory nature of the theater in specifically theatrical terms. Note, in the example above, that the anatomist used humiliation to encourage compliance among the transalpine students, but to do so, he created his own performance, mimicking first a transalpine student speaking Latin and second a drunk person speaking Latin. The theater, that is, opened up possibilities, derived from its theatrical or dramatic potential, for new or additional forms of regulation. For example, by the end of the sixteenth century, the anatomy theater in Padua housed demonstrations that were organized in such a way as to manufacture tranquility. Above the entrance of the permanent anatomy theater of 1595, an engraved list of names included proctors, procurators as well as the name of the presiding anatomist, the professor, Hieronymus Fabricius of Aquapendente. The demonstration began with a procession through that door, connecting the engraved list with the anatomist, endowing and displaying his authority in the context of the theatre. In addition to the processional beginning, a demonstration might also feature music.

The commentator, Jacopo Tomasini referred to music, taking his reference from the records of the transalpine nation. As the transalpine students described it, on 12 December 1597, a group of lute players entered the anatomical theater:

> To please the anatomy spectators and to raise them from their sad look, lute players led by the anatomy students had been brought into the theatre ([a practice] interrupted in the previous years)…those musicians were present as well for many days following, and the expenses were hardly to be regretted by those on whom they were imposed.[34]

[34] *Acta* , 1597, vol. 2, 111: "A.d. 12 Xbris ad exhilarandos anatomiae spectatores recreandosque ex tristi aspectu animos, ex vetusta consuetudine (quae tamen superioribus aliquot annis proximis interrupta) fidicines ab Anatomistis conducti et in Theatrum re-

With musical accompaniment, the annual anatomy demonstration stood in more explicit relation to other academic exercises—inaugural ceremonies and important addresses, which took place in theaters, as well as other lectures and events attended by academic officials and Venetian dignitaries.[35] Music was also functional, for it created a tranquil atmosphere inside the theater that discouraged interruptions of all kinds.[36] In 1600, the transalpine students again recorded the presence of musicians as well as a "throng of listeners" at the demonstration.[37] The student concluded that "thanks to this tranquillity the anatomy theater will be able to persist for quite a long time unharmed for some years." The Senate also expressed its support in 1595 for the anatomy theater, which brought "dignity" to the university, explaining that the theater is built "in a place most stable and highly honored"; it "will not be disturbed, as is the custom, every year by the bad behavior of the students [*maleficio de'scolari*]."[38] The theater would enhance the reputation of the university and the Republic, and it was inextricable from regulation.

ducti fuere, procurante hanc rem sedulo D. Placotomo; aderantque musici isti etiam sequentibus diebus quamplurimis, sumtus certe qui illis irrogantur minime poenitendi, si quidem dum ipsis attendunt et auscultant spectatores, ab omni tumultu et calcitratione supersedere solent, cuius tranquillitatis gratia Theatrum anatomicum aliquot annos diutius inconcussum durare poterit". The passage is also cited by Gamba 1986-1987, p. 160.

[35] Tomasini 1654, p. 79.

[36] Disputations were verbal exercises that engaged students, lecturers and professors. They followed the structure of narrow debates, including point, counterpoint, and resolution. On the medieval and Renaissance traditions of university disputation, see: Costello 1958; Grendler 2004; Clark 2006, pp. 74-80, 145-56.

[37] . *Acta*, 1600, vol. 2, 171: "[8 January] Ingruentibus iam magnis frigoribus, coeloque iam nives, pruinas, glacies que demittente, Excellentissimus Aquapends absoluta prius absolutissima in publico auditorio tam humanorum quam ceterorum animalium, ut et volucrium seu pennatorium ossium ostensione, postea quam tria extarent corpora seu subiecta, duo virilia, muliebre unum, ad sectionem solemni pompa cum fidicinibus ab Anatomisticis conductis accessit, eamque aliquot dierum spacio, frequenti sempre auditorum corona admodum evidenter administravit, et tandem post luculentam oculi dissectionem sectioni finem imposuit".

[38] *Senato Terra Registro 66*: "Perche l'Anatomia tanto necessaria alla Medicina, et cognitione tanto degna d'ogni studioso fosse detta, et tagliata nel studio nostro di Padoa con quella dignità che si ricevea à cosifatto studio, et con quel frutto, che si deve aspettar da cosi importante lettura et materia che si può dir delle più principali delle arti et medicina si è fabricato in quelle scuole nostre il theatro per farla in esso stabile, et honoratissimo, resta nondimenso à farsi provisione, esse non sia disturbata, come per l'aversoro [sic] si è fatto ogn'anno con maleficio de'scolari, et con non poca indegnità nostra pero".

Conclusion

The anatomy theater housed anatomy demonstrations that pursued a wide range of pedagogical goals, some exploratory, others introductory. From its inception, it was subject to institutional controls, professorial manners, and both rambunctious and submissive students. This history was infused with the cultural dynamics of the early modern university, and it was surprisingly coherent. The late sixteenth-century anatomist, Fabricius of Aquapendente gave demonstration after demonstration during a 40-year career that constituted an Aristotelian project of anatomical study[39], but his performances also emphasized his own authority. His performances, in part, responded to a trend identified in the work of his predecessors in which the hierarchy between professor and student had been diminished or rendered unstable. Perhaps Fabricius' demonstrations rectified certain deficits that were either caused by earlier anatomists such as Andreas Vesalius or, more likely, attributed to them after the fact.

The performative history of the anatomy theater emerges from both the archive of statutes and decrees and the repertoire of events. Within that history, we see how the limited resources of anatomy were encountered and countered; and we also find a pervasive, nearly constant concern for the behavior of students inside the theater. Indeed, as the archive and repertoire imply, the students of anatomy remain a critical part of its history.

[39] Cunningham 1997.

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SIXTEENTH-CENTURY UNIVERSITY GARDENS IN A MEDICAL AND BOTANICAL CONTEXT

Introduction

In the middle of the sixteenth century, a young physician from the south of Germany undertook a long journey in order to improve his professional knowledge. During this medical peregrination that lasted some seven years (1548-1555), Lorenz Gryll (also Laurentius Gryllus, 1524?-1560) visited nearly the whole of Western Europe. His trip was funded by the extremely wealthy Fugger family, and one of its explicit purposes was that Gryll – after his return to Germany – would help improve the standards of medicine and medical teaching in his native region by introducing what he had learned in the core zones of medical innovation in Europe, that is Italy and France.[1] Gryll's journey, which we can follow thanks to his own account, triggers the main themes in this contribution about university gardens, medicine and botany in the 16th century: how medicinal were these university gardens, and in which contexts can we study their functions and uses?[2]

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1 Gryll was from Landshut in Bavaria. He studied in Ingolstadt, Tubingen (with the famous botanist Leonhard Fuchs) and Vienna. See Gryllus 1566, which was published in that year, but finished in 1556. About Gryll, his journey and writings, see Cunningham 2010; cfr. Haye 2019.

2 The best works on Italian collecting and natural history are Findlen 1994 and Olmi 1992 with crucial discussions of fieldwork, sites of knowledge, and public/private aspects of naturalia collections. One of the most inspiring publications on 16th and 17th century botanical university gardens is Tongiorgi Tomasi 2005. These works will not be continually referred to below, but have informed the whole of this article. See further, on gardens and knowledge, the excellent Fischer et al. 2016. For references to specific gardens and themes, see the notes below.

DOI 10.48255/M.9788891320186.04

Medical peregrination and the Padua hortus

Gryll started by crossing the Alps, slowly. He explored the local flora on the way and spent the first years of his *peregrinatio* in northern Italy: after a stay of about two years in Venice and especially Padua with its famous medical school, he travelled on to Ferrara, Bologna, Florence, and Rome. For the latter city he especially mentions the Dutch physician Gisbert Horst(ius) who worked in the hospital of Santa Maria della Consolazione next to the Forum. Gryll went further south to Naples, which he praised for its expert pharmacists. From there he turned back north to Pisa, traveling via Genoa, Marseilles and Lyon to Montpellier, where he lived and studied for some time (c. 1550-51) in the house of the eminent physician-naturalist Guillaume Rondelet (1507-1566), who was engaged in writing his great work on fish that would appear in 1554.[3] Gryll continued his *tour de France* northwest-wards, and spent a long time in Paris, where he met many French and German physicians. From Paris, Gryll continued to the Low Countries. Travelling for a number of months between Bruges, Ghent, Amsterdam, Louvain and Brussels (where he met Andreas Vesalius), he then proceeded to the northern, central and eastern zones of Germany and adjacent Central European territories, before ending his journey in the Fugger-funded pox-hospital in Salzburg. Gryll died young, only about four years after returning from this journey.[4]

Gryll's account touches upon several interesting characteristics of medical training at the time. Many of these have been discussed by Cunningham, such as the strong emphasis on autopsy, direct and personal experience, the importance of learning medical *praxis* by seeing and participating and not merely reading books, and the need to observe and accompany the best physicians-teachers in Europe at work.[5] Here I want to draw attention to the importance of plants in the itinerary of Gryll. First of all – and even though his account does not go into great detail about any of his activities – he repeatedly points out that he paid much attention to the observation and identification of the plants that

[3] Rondelet 1554.

[4] See Gryllus 1566, and Cunningham 2010.

[5] Cunningham 2010. On observation and learning from practice in connection with early modern medicine and botany, see French 1985; De Angelis 2011; Stolberg 2013; and Egmond 2017. On Italian medical botany, see Palmer 1985a.

he encountered, whether during his travels in mountainous zones or while living for longer periods in a university town and exploring its environs and the countryside of that region.[6] During his *peregrinatio* Gryll showed a great interest, furthermore, in both indigenous and rare or exotic plants in the gardens that he found *en route*. He also closely studied the dried plants and plant substances (aromata, spices, gums, resins, et cetera) that arrived from far away, especially in the great ports of Venice, Naples and Antwerp, and the pharmacist's shops in these cities. Gryll's interest in plants was so strong, in fact, that he began to write his own commentaries on Dioscorides – as did several contemporary physician-naturalists, such as Pietro Andrea Mattioli (1501-1577) and Andrés Laguna (1510-1559).[7] Gryll's study of plants was by no means exceptional: all physicians at the time regarded the knowledge of medicinal plants (*materia medica*) as a 'core business' of their profession, since the vast majority of all medicines consisted of plant-based substances. To learn about plants, to be able to recognize and collect them, both fresh and dried, was in fact one of the main goals of Gryll's *peregrinatio*.[8] He called that expertise *doctrina & cognitio medicamentorum simplicium*.[9]

Looking at Gryll's account from the perspective of sites of knowledge, some further interesting aspects emerge that deserved to be inspected together and put into a somewhat wider context. These are the functions of university botanical gardens; the close links between those university gardens and the sites of (public) anatomical dissections; and the practice of botanical fieldwork. Gryll's account is all the more relevant since it covers the period 1548-55, while his stay in Italy must have been limited to the years 1548-50/51. Those are very early years in the history of botanical university gardens, as is immediately evident from a short list of the approximate founding years of the earliest European ones: Pisa 1543-44 (with two relocations/re-foundations still in the 16th century, in 1563 and the early 1590s); Padua 1545; Florence 1545; Valencia 1567; Bologna 1568; Jena 1586; Leiden 1593-94; Heidelberg 1593; Montpellier

[6] For the environs of Padua and the area between Rome and Naples, see Gryllus 1566, f. 4: folio numbers given in these notes refer to the folio numbering of Gryll's *Oratio*, which is part of this volume.

[7] Cunningham 2010, p. 15.

[8] Gryllus 1566, f. 15.

[9] Ivi, f. 12.

1593/1598.[10] Gryll travelled through Italy, therefore, at a time when the Padua, Pisa, and Florence gardens were very new and their collections of living plants and other naturalia in an early phase of development. Elsewhere in Europe, there were no university gardens yet during his journey.

Gryll mentions all three Italian university gardens that existed in his day. The first and foremost of these – in terms of international reputation – was the Padua hortus. The Venetian patrician, church official, humanist and collector but also expert on architecture, optics and mathematics Daniele Barbaro (1514-1570) had been one of the key figures in its foundation. At exactly the same moment in time, Padua was also known as the university where the most advanced medical-anatomical knowledge and practices were taught. In 1537, nine years before Gryll, Andreas Vesalius from Brussels had arrived in Padua, where he very soon became chair of the university's department for anatomy and surgery. He remained in this position until the early 1540s, and his famous *De Humani Corporis Fabrica Libri Septem* was published in 1543. As is well-known, precisely this combination of high-quality anatomical instruction and botanical facilities made Padua extremely attractive to northern students on their medical peregrination. In 1548-49/50 Gryll regularly attended both private and public dissections in Padua – not, of course, in its famous anatomical theatre, since that was only constructed half a century later (1594-95). Nor did Gryll neglect, as he put it, to avail himself of the extremely convenient opportunity that Padua offered to learn about plants, by visiting its hortus.[11]

Gryll writes that he went to the Padua garden because it gave him pleasure *and* because it was useful for his study of the great variety of plant species and shapes, which he could observe, examine and note down in writing; he also mentions plucking plants in the hortus, to keep

[10] Founding years are not always unequivocal, and depend on what moment is selected – the start of debate to create a garden; official decisions by university bodies; founding charters or statutes; the beginning of the lay out and planting; the opening of the actual garden – and naturally on available documentation. For details about the founding and relocations of the Pisa hortus, see Tongiorgi Tomasi 2005, pp. 98-100. The earliest university chairs for the teaching of medicinal botany were Italian too: Rome, 1513/14 in the form of a separate lectureship, and 1539, in that of a chair; Padua, 1533; Bologna, 1534.

[11] Gryllus 1566, f. 4. On the early history of the Padua hortus see esp. Azzi Visentini 1984; Minelli 1995.

– presumably in a personal herbarium with dried plants. The 1530s-40s are, in fact, the earliest years for which herbariums are documented that present large collections of systematically arranged and annotated dried plants.[12] The aims of the Venetian Senate in authorizing the creation of the garden had been somewhat different. Again in Gryll's words, the Senate wished to found a garden worthy of the great wealth and magnificence of Venice; it should host herbs, fruits, and foreign trees unknown to the common public that had been brought from all those parts of the world to which the explorations and investigations of the Venetians extended.[13] Put differently, the Venetian authorities saw the Padua hortus as a status symbol that could showcase the worldwide reach and magnificence of their city. Though the motivation was completely different, their goal overlapped to a considerable extent with the encyclopaedic aims of many naturalists at the time, who wanted to collect, document, and identify the huge variety of living nature.[14] The Padovan professors of medicine, who had campaigned at least from the mid 1530s for the creation of a university hortus, in their turn wanted a garden with living herbs to facilitate the teaching of medicinal botany to medical students and young physicians. Besides living plants, the hortus collection should, moreover, contain a "*speziaria*" with samples of dried medicinal plants and substances. These could serve as both teaching material and reference items against which to compare the many fake, mixed and substandard drugs that circulated in Venice – at the time the largest market city in Europe for drugs from the Middle and Far East.[15] The new hortus thus was intended from the start to serve many different purposes at once. Synergy would perhaps be the closest modern term to describe their connections and overlaps.

That multi-functionality does not appear to have changed in the following decades. In their analysis of botanical teaching in the 16th scentury Padua hortus during the 1560s-80s, Cappelletti and Ubrizsy have shown that medical students followed a theoretical course on medicinal

[12] Gryll does not mention a herbarium, but it is hard to imagine how else he would have kept these plants. For a recent survey of early European herbariums, see Thijsse 2016. The practice of plant drying is much older.

[13] Gryllus 1566, f. 4.

[14] Some of the most famous 16th-century naturalists with encyclopaedic aims are Gessner, Clusius and Aldrovandi. On early botany see esp. Ogilvie 2006.

[15] See Azzi Visentini 1984, here esp. p. 25.

plants as well as an *ostensio simplicium*, which consisted of showing the actual plants to the students in the botanical garden. Apparently, the booklets with a ground-plan of the four segments of the Padua garden and with blank pages in which each student could fill in the names of the plants per compartment came into use only after the prefecture of Melchiorre Guilandino (Melchior Wieland, c. 1520-1589), and thus some two decades after the garden's creation. In the 1550s-70s, along the lines devised by the Venetian Senate, the Padua hortus also continued to function as a repository for newly discovered plants from both Europe and other continents. According to the plant names written on Giovanni Vincenzo Pinelli's map of the Padua hortus, which dates from the years c. 1565-71, the garden had a tomato plant, tobacco and sunflower (from the New World), a lilac (from Turkey), and various other exotica.[16]

Anatomy and botany: Evidence of the senses

Was the early multi-functionality of the Padua hortus unusual, and can information about the plant collections and development of other university gardens provide new insights? A look at Leiden and Montpellier shows some interesting parallels with the Padua story, first of all in the proximity of two only apparently very different branches of medicine: anatomy and botany.

Gryll mentions his attendance at dissections and his visits to the Padua botanical garden in one and the same passage. He once more links the study of naturalia (plants and aquatic creatures) and his presence at anatomical dissections in the account of his stay in Montpellier. As mentioned above, Gryll lived there (c. 1550-51) for some time in the house of Guillaume Rondelet, naturalist, fish specialist, physician and anatomist, and teacher of many of the most famous naturalists of the later 16th century, such as Mattias de Lobel (1538-1616), Jacques Dalechamps (1513-1588), Carolus Clusius (1526-1609), Felix Platter (1536-1614), and Jean Bauhin (1541-1612).[17] In fact, not long after Gryll left Montpellier, he corresponded from Paris about Mediterranean fish and fish descriptions with Clusius, who at that time was himself a student-lodger in Rondelet's house in Montpellier. The two young men may even have met there, and some fifteen years later (1564) Clusius acted as paid tutor to one of the young Fuggers during the first part of his long journey *cum* fieldtrip through Spain and Portugal.[18] At the time of Gryll's and Clusius's studies in Montpellier, Rondelet was famous for taking his students on field expeditions into the hilly and wooded environs and to the nearby Mediterranean coast. Montpellier also had a great anatomical tradition. Dissections of human and animal bodies – sometimes illegally obtained, as Felix Platter describes for 1554 – were a common practice.[19]

The close connection between anatomy and medicinal botany in 16th-century universities concerned not merely the sites where knowledge was produced and transmitted but also the professional staff and methodology. Professors of medical anatomy regularly doubled as botanical experts and teachers, and used both their private houses and university buildings for teaching and practical demonstrations. To name only three examples, late in the 16th century Felix Platter in Basel combined a great reputation as an anatomist and eye specialist with an equally great one as naturalist and collector of naturalia. In Montpellier, Pierre Richer de Belleval (c. 1564-1632) was appointed to the combined chair of anatomy *and* botany in 1593. He started creating the *hortus botanicus* there in the same year upon the request of the French King Henry IV, though it would take many years (c. 1593-1605) for the garden to become fully functional. In Leiden, a similar personal union could be found in the person of the physician Petrus Paauw (1564-1617), who in 1598 took over as prefect of its hortus from the by then old and ill founder of the garden, the same Clusius with whom Gryll had corresponded almost fifty years earlier. Paauw was already teaching medical botany in Leiden, which also included on-the-spot teaching about medicinal plants. He had studied medicine in Paris, Orléans, Rostock and Padua, used human and animal bodies for his dissections, studied the development of the foetus and was – perhaps not coincidentally like Platter – reputed to have a great knowledge of the eye and the human skeleton. Such personal unions did not only exist at the

[16] Cappelletti & Ubrizsy 2012, pp. 76-78.

[17] Gryllus 1566, f. 6.

[18] These two letters (in Latin) from Gryll in Paris to Clusius in Montpellier, dated 24-12-1551 and 21-08-1552, are in Leiden University Library. On Clusius and his European correspondents, see Egmond 2010.

[19] On Montpellier medicine, see esp. Reeds 1991; on Rondelet, Clusius, and fieldwork, see also Lewis 2007; Egmond 2018, p. 181; and for descriptions of body snatching and private dissections in Platter's diary, see Loetscher 1976.

professorial level. In Leiden, during the late 1590s-early 1600s, the same person who acted as gardener's help in the hortus during the warmer part of the year also assisted with the dissections and anatomical lessons in the colder months. In various European universities – for instance in Basel, Montpellier and Leiden – botanical excursions in the field and lessons in the university garden in the warmer months formed a temporal counterpart of the public anatomical dissections and further anatomy lessons that were of necessity held mainly in the cold season.[20]

At a methodological and sensorial level, botany and anatomy matched closely, moreover. Field research of plants usually involved uprooting plants, cutting open bulbs, taking apart fruits and flowers, and paying meticulous attention to the evidence of sight, taste, smell and touch. In 1600, two French physicians even cut in half the bulb of a precious crown imperial and put the two halves back together in the soil – purely, it seems, for the sake of scientific curiosity. It is likely that their professional background inspired them to experiment with plants in a way that is reminiscent of human and animal dissections.[21] Close inspection in a botanical garden made students focus on the surfaces, structure, colours, and detailed characteristics of plants that distinguished them from similar species. Field botany and the recognition and identification of wild plants in their specific ecological context posed even higher demands on sensorial experience and its correct evaluation. In both outdoors plant research and anatomical lessons there was a strong emphasis on personal experience and observation (autopsy), comparison and discussion of that experience in a group, note taking and often drawing, the combination of information based on reading with that based on sensorial experience, and to some extent on manual dexterity. The concept of botanical anatomy was certainly known at this time: a manuscript album of 1583 with nature prints of plants and comparative drawings of plant parts by the German physician Theophilus Kentmann (1552-1610) bears the title *Botanatomia*.[22]

[20] See on the Leiden situation esp. Veendorp & Baas Becking 1938, p. 65; Tjon Sie Fat & de Jong Eds 1991; Egmond 2010, pp. 159-160; and Egmond 2016. On the complementary activities in winter and summer, see Paauw 1603, ff. 3-4.

[21] Letter from François de Saint-Vertunien (*c.* 1540-1607) to Clusius, 10-04-1601, Leiden University Library.

[22] Theophilus was a physician in Meissen and the son of naturalist-physician Johannes Kentmann, a friend of Conrad Gessner. Theophilus' manuscript has some 180 folios and together with his father's naturalia drawings forms the *Codex Kentmanus*, Herzogin Anna Amalia Bibliothek, Weimar, Fol. 323.

Fieldwork and the university gardens

As Cappelletti and Ubrizsy have pointed out, there is no proof that botanical fieldwork was used at the university of Padua *as a teaching practice* in the 1540s-50s. Yet, circumstantial evidence regarding other universities and contemporary practices makes it likely that Padua was no exception in this respect. Both Gryll's travel account and a wide range of information concerning the practices of medical students, physicians and naturalists – Italian and from other countries – points in the direction of a longstanding practice of botanical fieldwork that served a variety of different purposes.[23]

On the one hand, botanical fieldwork was of major importance to the collection acquisition of the botanical gardens newly created in the 16th century, whether these were privately owned or university-linked. Where else would rare European plants have come from? The naturalist Luigi Anguillara (*c.* 1512-*c.* 1570; original name Luigi Squalermo), for instance, was the first director of the Padua hortus in 1546-61. His fieldwork had begun much earlier, in 1539 at the very latest, and covered the whole of Italy, the south of France, as well as some of the Italian islands, Croatia, Albania, parts of northern Greece, Crete, and almost certainly also parts of Turkey, Syria and Tunisia. Late in the 16th century, Onorio Belli (1550-1604) donated many plants from Crete to the university gardens of Padua and Leiden as well as to various private botanical gardens in the environs of Verona. Belli lived on Crete from 1583 until *c.* 1600, first as a physician in the service of its Venetian governor-general and later as town physician of Chania. He had begun an ambitious project to investigate and chart as much of the Cretan flora as he could manage. During the second half of the sixteenth century professional and highly expert 'plant hunters' provided the exquisite botanical gardens founded by ruling noble families in Italy with rare plants from the wild. Giuseppe Casabona (*c.* 1535-1595; original name Joost Goedenhuyse), who came from the Netherlands, for instance, worked in the service of the Medici from the early 1570s and collected plants during fieldtrips in Tuscany, the foothills of the Alps, the area of Rome, the Apuan Alps, along the Ligurian coast, and on Corsica and Crete (1590-91). Shortly after Casab-

[23] Hodacs 2011, p. 192 rightly emphasizes with respect to Linnaeus and students how a modern separation of education and research can distort our understanding of a historical situation. This is, if possible, even more the case for the 16th century.

ona's return from Crete, he was appointed by the Medici to supervise the reconstruction of the Pisan hortus; in 1592 he became prefect of the new university garden.[24]

Fieldwork as a practice involving medicine students and teachers is particularly well documented for the second half of the 16th century. In Italy, Luca Ghini (1490-1556), teacher of a whole generation of Italian naturalists including Anguillara, Michele Merini, Andrea Cesalpino, and Ulisse Aldrovandi, undertook many botanical campaigns with his students and colleagues; the trip to the island of Elba and the ascent in 1554 of Monte Baldo on Lake Garda are best known. Extremely close in time to Gryll's stay in Padua was the Italian journey (1543-44) undertaken by the German naturalist Valerius Cordus (1515-1544) and his companions from north of the Alps. In the two years immediately preceding that journey, Cordus had already been a key figure in the introduction of botanical field work as a teaching method at the university of Wittenberg, where he studied and taught at the same time. While in Padua, Cordus supported those who were engaged in founding the hortus. In the spring of 1544 Cordus met up in Padua with several other young physicians and medicine students from north of the Alps. The group decided to travel further south and botanize along the way. They proceeded towards Rome via Livorno, Pisa, Lucca, Siena and Florence, collecting plants and studying fish along the coast. Cordus died shortly after arriving in Rome in September 1544.[25]

As the German example of Cordus and friends and the earlier mentioned activities of Rondelet and his Montpellier students show, fieldtrips were by no means limited to the Italian academic sphere in the years 1540-60. By the late 16th century fieldwork had become institutionalised in many parts of Europe and more clearly incorporated into the university curriculum. In 1590s Montpellier, for instance, the botanical garden's founder Pierre Richer de Belleval took groups of medical students of up to sixty participants botanizing in the countryside (Fig. 4.1).

[24] For a more extensive discussion of 16th-century botanical fieldwork and these examples, see EGMOND 2018, with further references.

[25] For fieldwork as a teaching practice, see especially OGILVIE 1996. The examples in this paragraph are discussed in more detail in EGMOND 2018. On Cordus's Wittenberg activities, see DANNENFELDT 1972, and on his support of the Padua hortus plan, see AZZI VISENTINI 1984, p. 25; cf. ONGARO 1970.

The Montpellier hortus served as both a focal point in teaching and a repository for the wild plants that Richer de Belleval and his assistants and students found in the surrounding countryside. He was also engaged in a – it seems more or less systematic – botanical exploration of the Languedoc with his students. This was, of course, as much part of teaching practice as innovative research. Richer de Belleval's dedicatory preface to his description and plant list of the Montpellier hortus of 1598 shows that not only medicinal plants formed part of its collection, and that he also considered a future investigation of the flora of the Pyrenees. In another treatise he phrased the description of his research into the flora of the Languedoc in utilitarian-medical terms, arguing that the French vastly underestimated the riches in medicinal and otherwise useful plants of their own flora, and that the variety in plant species of the Languedoc was directly related to its ecological diversity, or as he called it "*différence de territoir*". However pragmatically phrased, he emphasizes not only the "*divines & rares vertus*" of the plants of the Languedoc, but also their beauty.[26]

In an approach that looks strikingly modern, Belleval recreated that same ecological diversity in the Montpellier hortus itself. In 1604 the French antiquary, astronomer and archaeologist Nicolas Fabri de Peiresc (1580-1637) described its lay out in great detail in a letter to his friend Clusius in Leiden; a coloured drawing accompanies his letter (Fig. 4.4).

The hortus comprised a wet and shaded zone with water plants, a protected section for very rare or sensitive plants in pots, and at least three zones with different aridity or humidity, soil types, and structuring that replicated the diverse habitats of plants transplanted from the wild: one, as Peiresc writes, marked by N in de drawing, for the plants "that grow in rough, rocky, sunny places or along the seashore"; another (marked with O) that is shaped like a mountain for "plants that grow on slopes, mountains, in thickets, and gravelly places"; and yet another section for "plants that are found in shaded woods, in humid places, or in marshes and wetlands".[27]

[26] See REEDS (1991), esp. p. 89; and BELLEVAL 1598; IDEM 1605, pp. 2-5. The Montpellier and Leiden (see below) fieldtrips with groups of students show many similarities with those of almost 150 years later by Linnaeus and his students; see HODACS 2010; IDEM 2011.

[27] "Plantae quae in asperis, saxosis, apricis, et in ipso littore nascuntur […]. Plantae quae in clivis, montibus, frutetis, dumetis et sabulosis adolescunt […]. Plantae quae in umbrosus sylvis, udis, uliginosis et palustribus proveniunt"; letter (in French and Latin)

Close links existed in late 16th-century Leiden too between teaching medical students in the hortus, collecting rare plants in the field for the hortus collection, and field trips as teaching expeditions. In 1593, the university appointed the by then internationally renowned but elderly naturalist Carolus Clusius and the Dutch expert pharmacist Dirck Cluyt (1546-1598) to create its university garden. Clusius would be the prefect (director) of the Leiden hortus, while Cluyt would act as his second in command. Both had a vast knowledge of medicinal and non-medicinal, European and exotic plants. Both also had a long experience in creating gardens: in earlier decades Clusius had supervised the planning of an imperial court garden in Vienna and advised Wilhelm IV of Hesse-Kassel on the lay out and planting of his gardens. Together with some assistants Clusius and Cluyt laid out and planted the Leiden hortus in the spring and summer of 1594. It's simple rectangular shape, four squares, and straight beds suggest that practical horticultural reasons strongly influenced the layout, as was also the case – though resulting in a very different organization – in the contemporary new hortus of Montpellier.[28]

The pharmacist Dirck Cluyt was a botanical expert in his own right with a famous plant collection that comprised both medicinal herbs, exotica and European rarities. He had a personal international network of plant collectors and pharmacists, and Cluyt had worked very closely together with Pieter van Foreest (1521-1597), the most famous Dutch physician of the period, who in 1544 had been one of Valerius Cordus' companions during the latter's fatal journey from Padua to Rome.[29] During the earliest years of the Leiden hortus, Dirck Cluyt's son Outgert (Lat. Augerius Clutius; 1577-1636) regularly assisted his father in the *hortus* and instructed students there (Fig. 4.3).

He also took groups of Leiden medical students on herborizing trips in the dunes, peat bogs and woods of Holland. In spite of a request by

from Peiresc in Aix-en-Provence to Clusius in Leiden, 27-02-1604, published in Tamizey de Larroque 1898, pp. 948-950. For a detailed discussion of the Montpellier garden's construction and organization, see Rath 1998, who does not mention the coloured drawing with the Peiresc letter reproduced here, probably because it was not published by Tamizey. Rath suggests that the Montpellier garden may well be the first (university) garden organized on a habitat basis; on 16th-century notions of plant ecology see Ubrizsy Savoia 1998.

[28] See Egmond 2010, esp. pp. 157-164; and Egmond 2016.

[29] Cluyt married the niece of Foreest's wife. Foreest was personal physician of Prince William of Orange, leader of the Dutch Revolt.

the medical students, Leiden's university board refused to appoint Outgert as his father's successor when Dirck Cluyt died young in 1598. According to the students, Cluyt Jr was the only person who understood the *register* of the Leiden hortus – which should warn us that such early university collections were not always systematically organized or administered. The young Cluyt also had good Latin and Greek (unlike his father) as well as great ability and expertise in drying plants and the preparation of medicines. The missed Leiden appointment of 1598 actually furthered the career of Outgert Cluyt, who was already a trained pharmacist by this time: he went on to study medicine in Montpellier, where he assisted Richer de Belleval with the development of the new university garden; he travelled and botanized in Spain and North-Africa, from where he sent back seeds and other plant material to the Leiden hortus; and he eventually returned to Holland (1607), where he became a highly respected physician and botanist.[30]

These are not the only traces of how plants and seeds collected during field expeditions of young Dutch physicians entered the collection of the Leiden hortus during the first fifteen or so years of its existence.[31] Further plant material arrived in Leiden, for example, via Clusius's correspondent Tobias Roels, a young physician from Zealand, whose medical peregrination had taken him across the Alps and to Padua in the years 1589-91. Just like Gryll half a century earlier, Roels familiarized himself with the plants in the Padua botanical garden. And just like Cordus, he undertook botanizing trips from Padua, for example to the Tyrolean Alps. One of his companions was his fellow student Joachim Jungermann (1561-1591), the nephew of Clusius's close friend Joachim II Camerarius, and the presumed artist of the famous *Camerarius Florilegium*. Jungermann died shortly afterwards on his way to Crete for a botanizing trip in Greece and the Levant with Giuseppe Casabona, the 'plant hunter' who worked for the Medici.[32]

[30] During his travels, Cluyt Junior developed contacts with physicians and botanists in Padua and Montpellier, with the herborists of the Medici in Florence, and those of the French king, father and son Robin in Paris. See Egmond 2010, pp. 157-164.

[31] On the early years of the Leiden hortus and its living collection see esp. Veendorp & Baas Becking 1938; de Jong 1991; Van Uffelen 2008; Idem 2009; Idem 2012; Van Uffelen & Kessler 2015; Egmond 2010, pp. 157-164; Egmond 2016; and Grämiger 2016 who overestimates the role of Paauw, however, in the very first years of the hortus's creation (1593-94).

[32] See Egmond 2010, esp. pp. 141-155.

From the creation of the earliest Italian university gardens in the 1540s, multiple connections can thus be traced between these gardens as sites of knowledge and locations where medical students were taught about *materia medica*; fieldwork (whether as official teaching method or as an extra-universitary activity) as a formative experience in the professional identity of physicians, naturalists and most probably also pharmacists; and fieldwork as a means to create, maintain and expand the collections of the university gardens.[33] It is important, however, to emphasize that the outdoors study of living plants long predates the founding of university gardens. This does not merely apply to the probably age-old tradition of examining and collecting medicinal herbs in the wild by local medical practitioners and herb women. It also concerns the outdoors examination of living plants as an explicit teaching method, as Olariu has shown. In his analysis of the treatise *Aggregatio simplicium medicinarum* composed in 1453 by Mathaeus Bolderius (who taught medicine in both Bologna and Padua), Olariu demonstrates that botanical autopsy outdoors using all the senses was part of the teaching practice in Padua university already a century before its hortus was founded.[34]

Seen in this long-term perspective, it is likely therefore that the European university gardens founded from the early 1540s onwards were an institutional innovation of (and addition to) an autoptic practice already since long regarded as indispensable to the education of medical students. While plant observation had formerly required trips to private gardens and out into the field, the university gardens offered more convenient sites of knowledge in the vicinity of other university constructions. The university gardens were planned and organized. They offered a controlled experience – can we speak of a laboratory? – of the world of plants and kept the chaos of real, 'wild' nature outside.[35]

[33] On the complex issue of the status, training and image of apothecaries, which were not identical throughout Europe, see (for Italy) e.g. Palmer 1985b and Di Gennaro Splendore 2017.

[34] The single exemplar of Bolderius's text survives via a manuscript by his student, the Nuremberg physician, humanist and cartographer Hartmann Schedel (1440-1514); see Olariu 2019.

[35] See Fleischer 2016 on stabilizing botanical knowledge in 17th-century gardens in Northern Europe. I do not want to push the comparison with the laboratory as site of experimentation, precisely because these gardens had so many different functions and uses.

Public and private collections of living plants

Some further considerations serve to contextualize the roles and functions of the 16th-century university botanical gardens. First and foremost, these university gardens were by no means the only botanical collections of early-modern Europe; they were unquestionably not the earliest ones; and they were almost certainly not the richest ones either. Large numbers of *private* botanical gardens existed in mid 16th-century Europe, many of them founded by physicians and pharmacists. In 1561 Conrad Gessner published one of the few surveys of such gardens; it roughly covers the German-speaking world and some adjacent territories.[36] Since outdoors botanical inspections and trips of medical students long predated the founding of university gardens, we may assume that private gardens played some part in the learning process of these students. The following examples point clearly in this direction.[37]

Evidence from late 16th-century Padua and Leiden shows that university plant collections and private botanical gardens in these towns were not strictly separated.[38] Medicine students and young physicians could have access to both. One of the richest private gardens in Padua during the 1590s was the one created by Torquato Bembo (born 1525), son of Cardinal Pietro Bembo (1470-1547). In 1590-91, the Bembo garden hosted a number of exotic plants that belonged to Joachim Jungermann, the same young physician-naturalist who died in 1591 on his way to Crete.[39] In Leiden during the early 1590s – just before the opening of the university garden – the private gardens of professors such as Justus Lipsius and Pieter Paauw were used for teaching until the *hortus*

[36] Gessner 1561, pp. 236-298. To my knowledge no modern surveys exists of private botanical gardens in or before the 16th century for any other part of Europe. But see Schmölz-Häberlein 2013, 2015. More generally on the theme of private-public and the history of naturalia collections, see Beretta 2005.

[37] Lauterbach 2016, who focuses on urban German gardens of the 16th to 18th centuries, places 'scientific botany' far more exclusively in university gardens and some court gardens than I do here; she does not discuss Italy, and sees the German urban gardens especially in terms of civic pride and 'corporate identity'.

[38] For the mid 16th century Maggioni 1970, p. 6 mentions several further private and convent gardens for Padua that contained rare and exotic plants. A large part of Azzi Visentini 1984 is devoted to the discussion of (private gardens as) sources and models for the Padua hortus. I am not going into the history of garden design here, however.

[39] Bussadori 1988, p. 52; and Olmi 2007, pp. 350-353.

botanicus was ready.[40] Of course, these private gardens did not disappear or close after the opening of the Leiden hortus, and in fact several further magnificent private gardens in and near Leiden are known to have co-existed with the university hortus in the 1590s-1610s. The best of those private gardens can be qualified as combined medicinal gardens and botanical research collections, and had been created in the last two decades of the 16th century by either pharmacists or patrician collectors who also were in personal contact with the Leiden hortus. Collection exchanges took place between all these gardens in the small town of Leiden, and we know of personal contacts and friendships between their owners.[41]

For the most famous private botanical gardens in Europe that flourished during the 1540s-60s – and thus co-existed with or even preceded the early university gardens – direct use by medical students still needs to be investigated. The relevance of two such gardens for plant-medicinal research is more than evident, however, since they were created by professional pharmacists who used their gardens not merely themselves, but also opened them to expert colleagues and young physicians-naturalists. The gardens of Georg Oellinger (1487-1557) in Nuremberg and Peeter van Coudenberghe (1517-1599) in Antwerp contained large numbers of living indigenous and exotic plants as well as dried (often exotic) plant substances. Both had many medicinal herbs, but neither was a purely medicinal garden. Oellinger, a wealthy pharmacist and local dignitary in Nuremberg, had started a private garden as early as the 1520s. He visually documented this plant collection in 1553 in a famous manuscript album of almost 650 pages with mainly plant drawings: *Magnarum Medicinae partium herbariae et zoographiae imagines*.[42] The young Valerius Cordus visited Oellinger's garden in the course of his 1542 journey-fieldtrip through Germany, probably together with his student-companions. Oellinger also seems to have been instrumental in Cordus's presentation of his *Dispensatorium* (the earliest German

[40] van Uffelen & Kessler 2015, p. 15.

[41] For a more detailed discussion, see Egmond 2010, pp. 157-173; and Egmond 2016.

[42] University Library Erlangen-Nuremberg, shelf mark H62/MS 2362 (the album can be consulted online at this library). See Ludwig 1998, pp. 18-23, who discusses the Oellinger herbarium in the context of Nuremberg plant and flower painting.

pharmacopoeia) to the Nuremberg council, who accepted it and published it (posthumously) in 1546.[43]

Coudenberghe first planted his Antwerp garden in 1548. Guicciardini praised it in his *Descrittione di tutti i paesi bassi* (1567) as incredibly rich in species, and Coudenberghe himself spoke of some 600 exotic plants alone. Some of the drawings of his plants and of dried (often exotic) plant material such as resins, nuts, spices and woods, formed the basis for illustrations in Clusius's work on exotic medicinal plants. The fame of Coudenberghe's garden was such that some of the most famous naturalists of this period came to see it; Gessner, Dodoens, Lobel and Clusius refer in their printed works to information and plants received from him. Coudenberghe was no modest apothecary trained in practice, but a wealthy member of the Brussels patriciate with impeccable Latin. Interestingly, he corrected new editions (1568, 1571, 1579) of Valerius Cordus's *Dispensatorium* – undoubtedly making use of his experience with medicinal plants in his Antwerp garden. The Coudenberghe garden was destroyed during its founder's lifetime, most likely in 1585 by the troops of Alessandro Farnese during the siege of Antwerp.[44]

Although most 16th-century university gardens were accessible to the public, while private gardens were generally only open to relatives and guests of the owners, the distinction between them was fluid in other respects. This is perhaps most evident when we look at their contents. Some of the university gardens actually grew out of the private collections of ruling aristocrats. The most famous examples are the university gardens of Pisa (founded 1543) and Florence (founded 1545) which evolved from private gardens of the ruling Medici family. The Medici gardens already had a great reputation, famous plant collections, and highly expert staff long before they became associated with the universities.[45] Nor did the functions of these gardens suddenly or drastically change with the transition from private to public: they were and remained places of research, curiosity, delight, entertainment, experiment,

[43] See Cordus's list of plants that he first observed in 1542 and during this trip, with some direct references to plants seen in Oellinger's garden, Cordus 1561. On exotic plants in gardens of south-west Germany, see Schmölz-Häberlein 2019.

[44] I have used the 1581-edition of Guicciardini 1581, p. 11; and the 1579-Coudenberghe edition of Cordus. On Coudenberghe and his garden, see VandeWiele 1993; and Egmond 2010, pp. 17-22.

[45] See Acidini Luchinat 2000.

prestige, display, and magnificence. The active involvement of the Medici themselves also continued, both in an institutional sense and in terms of interest in the collection. In fact, Gryll places Cosimo I de' Medici (1519-1574) in his long list of rulers – starting, of course, in antiquity – who had great personal expertise concerning plants and their uses in agriculture, food, and medicine: "Cosimo de' Medici, the praise-worthiest ruler of Etruria [=Tuscany] whose two gardens in Pisa and Florence are both stocked with a variety of plants, knows the name and properties of all but a few".[46] And that was written *after* the Medici gardens had become university gardens.

While in Pisa and Florence the whole garden thus changed its status, in many other cases private plant collections were literally transplanted to or otherwise incorporated in newly created university gardens, where they contributed in crucial ways to the identity of these new collections. Anguillara, the first director of the Padua hortus (1546-61), moved back and forth between the 'public' and the 'private' sector. Both before and after his employment at the Padua hortus he worked in the private gardens of the highest aristocratic families in Italy: before 1546 in Bologna and Pisa; after 1561 in Ferrara.[47] Plants that he collected during extensive fieldwork entered these collections, and it is impossible to believe that some plants would not have moved with him. Rare plants from the famous private botanical garden in Venice of the patrician-naturalist Pietro Antonio Michiel (c. 1510-1576) must also have found their way into the Padua hortus while he acted as its supervisor and as advisor to its first prefect, Anguillara, in 1551-56.[48]

For the Leiden hortus some detailed evidence is available about the provenance of the plant material used in its creation by Clusius and Cluyt in 1593-94. Van Uffelen, who recreated the Clusius-garden in 2009 on its original location within the modern (and much larger) Leiden hortus, used plant lists from 1594-95 (*Index Stirpium*) for this purpose. There were medicinal plants such as mandrake and foxglove, herbs such

[46] GRYLLUS 1566, ff. 13v-14r. For the continued institutional involvement of the Medici, see TONGIORGI TOMASI 2005, pp. 98-100; and for a special volume devoted to the Pisa garden and its history, see GARBARI ET AL. 2002.

[47] EGMOND 2018, p. 174.

[48] The exact dates of Michiel's garden are unknown, but he must have started collecting plants during or before the 1540s. From 1555 until his death Michiel had more than a thousand plants depicted in various albums. See MASON & PARDO TOMÁS 2020.

as rosemary and thyme, but also many decorative garden plants such as pinks and primulas,

> [...] some European, many Mediterranean ones, and some of even more exotic origins, such as sugar cane and tomatoes. [...] The garden had a large number of bulbous and tuberous plants, such as crocuses, hyacinths, anemones, and tulips. Most of the plants had no medicinal function; it was a hortus botanicus, with a collection for research, teaching, and pleasure, rather than a hortus medicus.[49]

Both Clusius and Cluyt transferred large numbers of plants from their personal gardens to the Leiden hortus. Clusius had transported plants, roots, bulbs and cuttings as well as a collection of seeds from Frankfurt. His own garden there had included plants that Clusius himself had collected during many journeys and field trips in Europe; bulbs received from Constantinople and the Levant; and rare plants from Southern Europe and France, in particular gifts from friends in Italy, Crete, and the Provence. Clusius' plant collection thus reflected the international research interests of European naturalists as well as the fashionable interests of aristocratic collectors. Cluyt's personal garden was both a pharmacists' garden of medicinal herbs and a botanical research garden; it had large numbers of rare plants as well as dried specimens. Leiden university accepted hundreds of rare plants from Cluyt to stock the hortus.[50] The third key figure in the creation of the Leiden hortus was the physician-anatomist Petrus Paauw (hortus director from 1598 until his death in 1617). It was he who initiated the construction of the *Ambulacrum* (1601): a long building that flanked one side of the garden and served as both conservatory to protect sensitive plants from the

[49] VAN UFFELEN 2009, p. 21: Cluyt presented the *Index Stirpium* as a report of activities to the Board of Leiden University on 9 February 1595; cf. VAN UFFELEN & KESSLER 2015. See also EGMOND 2010; IDEM 2016; and GRÄMIGER 2016, who uses this same *Index Stirpium*, but focuses more on the order of planting. For the 1603 planting list of the Leiden hortus, see PAAUW 1603.

[50] If Paludanus had become prefect of the *hortus*, part of his famous collections would have accompanied him to Leiden, as specified in the university's invitation of 1591. Between Cluyt and the university financial problems arose almost immediately after his appointment (and persisted until after his death) in connection with insufficient financial compensation by the university for Cluyt's valuable plant collection. Cluyt himself estimated its value at c. 1,500 guilders – a fortune. See for more details EGMOND 2010, pp. 157-160.

winter cold and gallery for the display of rare *naturalia* and ethnographica. Many of those items – especially naturalia and ethnographica from the East Indies – came from Paauw's private collection.[51]

The Leiden *hortus* thus did not originate as a specifically medicinal garden, but as a research and experimental botanical garden with a considerable number of rare plants from various parts of Europe and the Levant as well as some living exotica from other continents. During the first phase of its existence (1593-1602) the private collections of Clusius, Cluyt and Paauw were no additional stocks, but the substantial core of its living collection in the garden and its curiosa in the *Ambulacrum*. The Leiden anatomical theatre too depended on the incorporation of several different private collections which had originated outside a university setting and had been shaped by fashions, passions and fascinations that overlapped but were not identical with academic purposes.[52] While all early plant collections of the sixteenth-century university gardens in Europe were used to teach medical students and young physicians about medicinal plants, those collections – thanks to their variegated origins – reflected the purposes and interests of private collectors (aristocrats, professional naturalists or apothecaries) as much as the training exigencies for medical students.

Finally, with respect to the contextualization of university gardens, it is interesting to note that the governing boards of 16th-century universities regularly operated like aristocratic patrons in their approach to and uses of these gardens and the anatomical theatres. Concepts of urban honour, glory, and magnificence were closely linked with the foundation of these structures, as we have already seen in the case of the Padua garden. Leiden's university too discussed the founding of the garden and anatomical theatre in terms of urban and indeed national prestige, and of competition with other universities.[53] While the Padua garden was supposed to show and symbolize the worldwide extension of Venice's mercantile contacts, the Leiden hortus too came to be used as a symbol of the rapidly expanding Dutch reach overseas and as a repository of

[51] For some remarks about Paauw's collection in the *Ambulacrum*, see Paauw 1603.

[52] See Lunsingh Scheurleer 1975; and Rupp 1991.

[53] Leiden University itself was founded in 1575 on the personal initiative of Prince William of Orange, as symbol of the Dutch Republic's independence from Habsburg Spain, and therefore as a direct rival to the much older university of Louvain in the Southern Netherlands.

exotic naturalia within the first two decades of its existence. On the engraving of 1610 that represents the layout and planting of the Leiden hortus, the gallery which housed Paauw's exotica can be seen in the background (Fig. 4.4).

Some of its contents are depicted in the foreground, such as two 'crocodiles', the shells of an enormous sea-turtle, a blowfish, and the jawbone of a (polar) bear from *Nova Zembla* (Novaya Zemlya), which in 1596-97 had been the location of the dramatic overwintering of the Dutch navigator Willem Barentsz and his companions in the Arctic seas north of Russia. Depicted as growing in the garden itself, there are at least two recognizable exotic plants which form a symbolic counterpart to the dried exotic animals in the foreground: the bamboo close to the wall on the left, and the crown imperial (*fritillaria imperialis*) in a fenced-off section meant for special rarities in the left bottom corner of the image. The crown imperial had first appeared in Europe not long before 1600, and quickly became one of the most fashionable and prestigious plants; it was widely used as symbol of rarity and high status in decorative arts, flower still lifes, and of course alive in gardens.[54]

Plans to create a collection attached to the hortus also existed in late 16th-century Montpellier and Padua. On the drawing of Belleval's Montpellier hortus of 1604 (Fig. 4.2), the letter M marks "a large gallery that should be filled with animal skins, minerals and all other kinds of natural *singularités*".[55] For Padua a museum was planned as well. The publication of 1591 printed by Girolamo Porro from Venice, which also contains the earliest plan of the Padua hortus, describes various improvements to the garden (Fig. 4.5). These included a fountain and several statues as well as a series of rooms along the outer walls of the garden. Some of those would be used for various medicine-connected practices, such as distilling and smelting. Others would function as a museum, with one room for minerals, stones, and earths; one for all aquatic creatures; one for the animals living on land; and one for the birds. Together they would form a "beautiful and marvellous museum", and in this "small theatre, as if in a small world there

[54] On the 1610 engraving, which figures in nearly all publications about the Leiden hortus, see in particular Tjon Sie Fat & De Jong Eds 1991, pp. 3-12, 37-60.

[55] "L'M marque une grande galerie qui se doibt remplir de peaux d'animaulx, de mineraulx et de toutes les aultres singularites de nature"; letter (in French and Latin) from Peiresc in Aix-en-Provence to Clusius in Leiden, 27-02-1604, published in Tamizey de Larroque 1898, pp. 948-950.

will be the show of all the marvels of nature".[56] Living plants from all parts of the globe would thus be matched by a micro-world of nature indoors. Both showed the global dominance of its owners.

Conclusion

This excursion through some 16th-century university gardens shows that their collections were multifunctional from the very beginning, which strongly suggests that they should not be regarded in a disciplinary (either medical or botanical) way or even in a purely academic one. Gryll's example indicates that students of medicine themselves did not regard these gardens as merely sites of learning. And the ruling princes, urban governors, guilds of pharmacists, and university officials involved in their creation were interested in both the display of the magnificence of their institutions and the quality of medical-botanical teaching. The one enhanced the other. The important role of private plant collections as constitutive collections of the early university gardens, the permanent interaction in the course of the 16th century between university and private gardens in terms of staff and plant material, and the importance of physicians and pharmacists as creators of private botanical gardens in various European countries, all indicate how important it is not to separate the university gardens of the 16th century from the wider phenomenon of early modern plant collecting and plant-medicinal research. The very multifunctionality of the early university gardens also raises questions about their presumed development in the course of the 16th and early 17th centuries. The examples discussed here indicate that no single pattern applied to all – neither the path from mainly display and delight to science, nor that from teaching to research garden, nor the one from mainly utilitarian medicinal plant collection to botanical research garden and eventually to display garden. Their appeal to the senses remained as much about beauty as about science.

[56] "Et in questo picciolo Theatro, quasi in un picciol mondo si farà spettacolo di tutte le meraviglie della Natura"; see Porro 1591, unpaginated, unsigned introductory statement; it seems to be still uncertain whether Porro is not only the printer but also the author of this work. There are various other examples of museums or *Wunderkammern* attached to late 16th-century university gardens. See Findlen 1991; and Tosi 2005, esp. pp. 54-55.

Fig. 4.1. Plant illustration (moly) from Pierre Richer de Belleval, *Dessein touchant la recherche des plantes du Pays de Languedoc*, Jean Gillet, Montpellier, 1605.

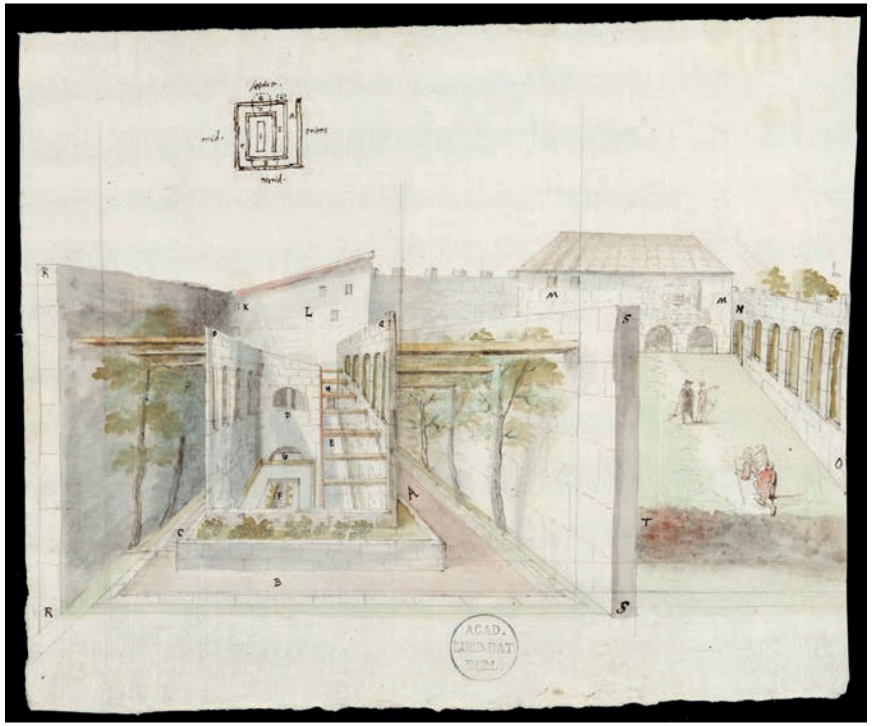


Fig. 4.2. Drawing of the Montpellier hortus by Nicolas Fabri de Peiresc, in a letter from Peiresc in Aix-en-Provence to Carolus Clusius in Leiden, 27-02-1604. Leiden University Library, VUL 101.

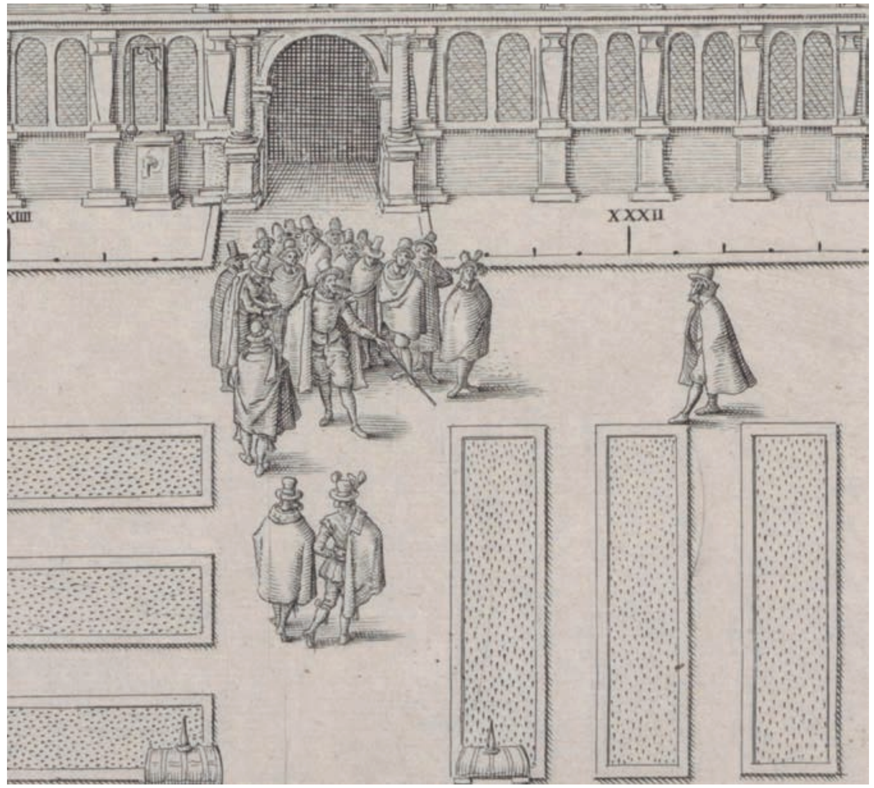


Fig. 4.3. Teaching in the Leiden hortus. Detail of an engraving of the Leiden hortus by Jacob de Gheyn (II), 1601.

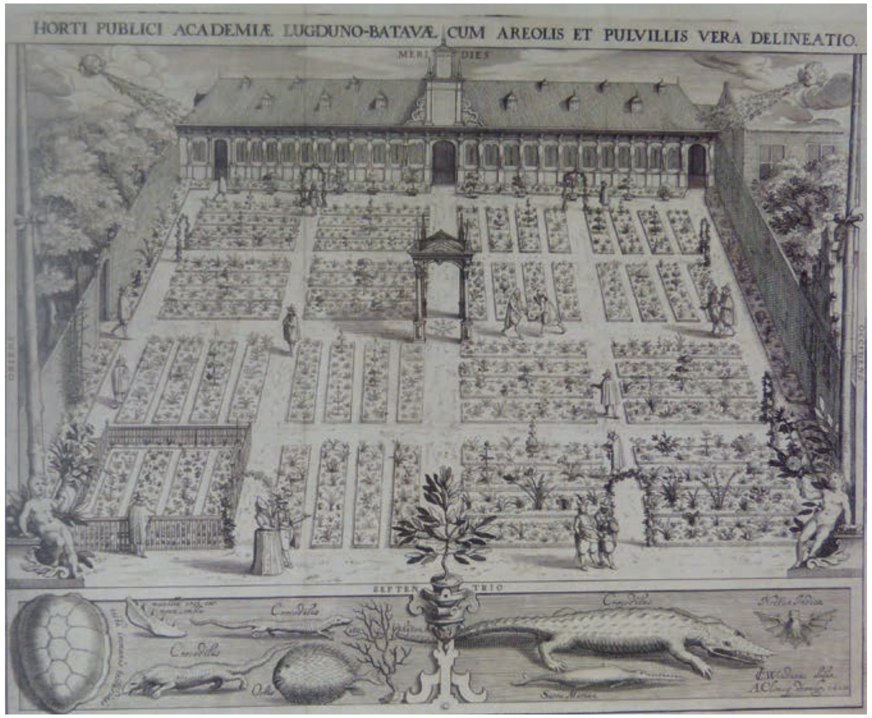
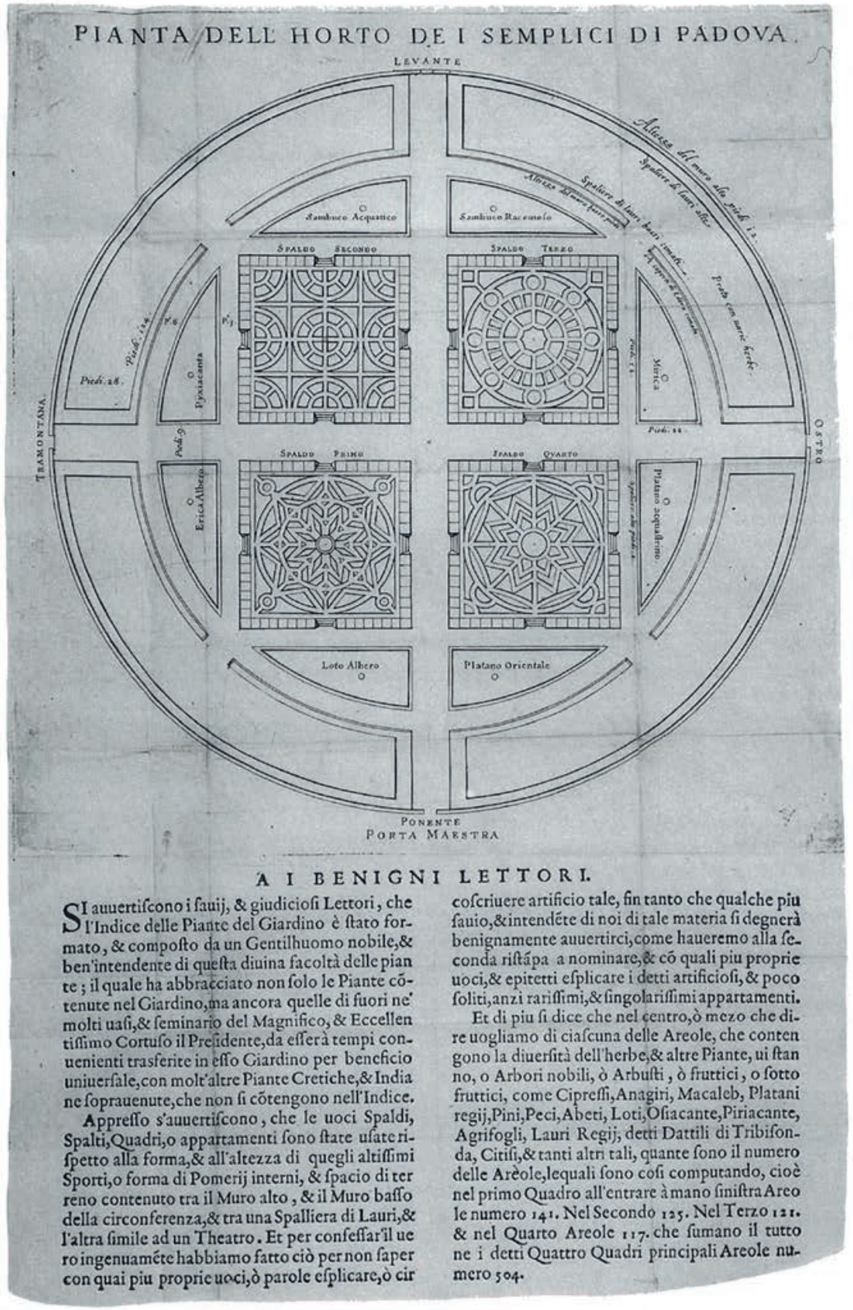


Fig. 4.4. The Leiden hortus with its gallery, and some exotica in the foreground. Print by Jan Cornelisz. Woudanus and Willem Isaacsz. van Swanenburg, 1610.



A I BENIGNI LETTORI.

SI auuertiſcono i ſauij, & giudicioſi Lettori, che l'Indice delle Piante del Giardino è ſtato formato, & compoſto da un Gentilhuomo nobile,& ben'intendente di queſta diuina facoltà delle piante; il quale ha abbracciato non ſolo le Piante cõtenute nel Giardino,ma ancora quelle di fuori ne' molti uaſi,& ſeminario del Magnifico, & Eccellentiſſimo Cortuſo il Preſidente,da eſſer à tempi conuenienti trasferite in eſſo Giardino per beneficio uniuerſale,con molt'altre Piante Cretiche,& Indiane ſoprauenute,che non ſi cõtengono nell'Indice.

Appreſſo s'auuertiſcono, che le uoci Spaldi, Spalti,Quadri,o appartamenti ſono ſtate uſate riſpetto alla forma,& all'altezza di quegli altiſſimi Sporti,o forma di Pomerij interni, & ſpacio di terreno contenuto tra il Muro alto , & il Muro baſſo della circonferenza,& tra una Spalliera di Lauri,& l'altra ſimile ad un Theatro . Et per confeſſar'il uero ingenuamẽte habbiamo fatto ciò per non ſaper con quai piu proprie uoci,ò parole eſplicare,ò circoſcriuere artificio tale, fin tanto che qualche piu ſauio,&intendẽte di noi di tale materia ſi degnerà benignamente auuertirci,come haueremo alla ſeconda riſtãpa a nominare,& cõ quali piu proprie uoci,& epitetti eſplicare i detti artificioſi, & poco ſoliti,anzi rariſſimi,& ſingolariſſimi appartamenti.

Et di piu ſi dice che nel centro,ò mezo che dire uogliamo di ciaſcuna delle Areole, che contengono la diuerſità dell'herbe,& altre Piante, ui ſtanno, o Arbori nobili, ò Arbuſti , ò fruttici , o ſotto fruttici, come Cipreſſi,Anagiri, Macaleb, Platani regij,Pini,Peci,Abeti, Loti,Oſiacante,Piriacante, Agrifogli, Lauri Regij, detti Dattili di Tribiſonda, Citiſi,& tanti altri tali, quante ſono il numero delle Arèole,lequali ſono coſi computando, cioè nel primo Quadro all'entrare à mano ſiniſtra Areole numero 141. Nel Secondo 125. Nel Terzo 121. & nel Quarto Areole 117. che ſumano il tutto ne i detti Quattro Quadri principali Areole numero 504.

Fig. 4.5. Oldest plan of the Padua hortus, in Porro, 1591.

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Alberto Zanatta*

THE ORIGIN AND DEVELOPMENT OF MEDICAL MUSEUM HERITAGE IN PADUA

Introduction

The University of Padua is one of the oldest in the world. It was founded in 1222 when several teachers and scholars left the University of Bologna, looking for more freedom of research and teaching, which were granted by Padua.

During the XV century, the Republic of Venice made Padua University the main educational centre of the Republic, increasing substantially the research. Venice signed up the best professors and guaranteed them the "*Libertas docendi et investigandi*" (freedom of research and teaching), as it is written in the University's motto "*Universa universis patavina libertas*", that means "The freedom of Padua is universal and for everyone".[1]

In this atmosphere of freedom, the Padua scientific museology began with the founding of the Botanical Garden, called Garden of Simples, in 1545. The "Simples" were the remedies directly obtained from plants without any further concoction: for this reason, it was named "*Hortus Simplicium*". The Botanical Garden was born with a strictly medical purpose, but the project was wider, in line with the scope and horizons of the medical science of the time, which went far beyond the current borders. In 1591 a text was published in Venice with the title: "The Garden of Simples of Padua, where for the first time you see the shape of its whole map with its measures [...]",[2] in which there are some interesting

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1 Zampieri, et al. 2013.

2 Porro 1591.

DOI 10.48255/M.9788891320186.05

descriptions that make us understand how Botanical Garden had also a museum purpose. The author writes about several rooms that had to be built around the Garden wall and had to be devoted to the experiments "on medical matter". This "beautiful, strange and marvellous museum consisting of such a wide variety of objects of different orders" was to be a small Theatro for the benefit of scholars.[3] Unfortunately, there was no real continuation to this program. In fact, the Botanic Garden nowadays can be considered a living museum, thanks to the large number of plants preserved in it.

The real scientific museology began in Padua with the Museum of Natural Philosophy of Antonio Vallisneri senior (1661-1730), professor of practical medicine at the University of Padua.[4] Vallisneri owned privately all the collections, that were modelled on those of the eighteenth century. Vallisneri started to collect specimens since the end of the seventeenth century thanks to all his travel around Italy and Europe, from where he always returned home with lots of rare productions of Nature and arts. The purpose of the Museum of Natural Philosophy was to educate students and demonstrate what Vallisneri called "philosophical curiosity", a curiosity that was not an end in itself, but was intended to be primarily a stimulus to know Nature. A different concept from the sixteenth century Cabinet of curiosities.

In 1733, after the death of Vallisneri, his son Antonio Vallisneri junior (1708-1777) donated the collection to the University of Padua, becoming the first university museum, constantly enriched during the eighteenth century. Following Vallisneri's example, Giovanni Poleni (1683-1761), physicist and mathematician at the University of Padua, established the Theatre of Experimental Philosophy in 1740. It was the first museum-laboratory of physics in a University.

The scientific cabinets and the experimental laboratories of the University of Padua of the XIX century came from the Museum of Vallisneri and the Theatre of Poleni. For example, the Zoological Museum of the University of Padua, as others collections of Istitutes and Departments, rose from the Vallisnerian collections.

[3] Ibidem.

[4] Zanatta & Rippa Bonati 2016.

Medical museums in Padua

The Padua medical museology, in particular, started officially with the anatomical museum of Giovanni Battista Morgagni (1682-1771) in 1756. Morgagni planned the creation of a museum of anatomical and pathological specimens and called the architect Giorgio Domenico Fossati (1705-1785) to make a project of it. This new museum should be placed in a room of the Bo Palace, a sort of attic, close to the anatomical theatre, built in 1595 under the professorship of Fabricius ab Aquapendente (1537-1619), and where Morgagni himself had dissected bodies for over fifty years. This project unfortunately was never realized, and only a plant and a section remain, where Fossati provided for an oval-shaped room covered by a false vault decorated at the base with carved wooden decorations and in the centre by a small lantern.[5]

Morgagni, anyway, performed many anatomical preparations, in particular of the ear and bones, which proudly showed to colleagues who were visiting him in his office/museum.[6] In 1771, few days before Morgagni death, a young Cappuccino visited him in his office that was described as a sort of museum: "I satisfied Morgagni to visit him sometimes; and I used to meet him in his Museum, seated at a walnut table wearing a cone cap on the head. Opposite, he kept a tall skeleton that he made from a corpse of a cop, who was killed".[7]

Another important museum is that of Luigi Calza (1736-1783), professor of "*De morbis mulierum, puerorum et artificum*" at the Padua University from 1765. Calza founded the first Cabinets of Obstetrics for physician in 1769 and a private school for midwifes, the *Scola Ostetrica*, in 1774. This museum was composed by a series of anatomic models in wax and clay, used for Calza's practical teaching to the pupils. The wax models represented, life-size, the anatomy of the female reproductive tract, the physiology and the pathology of the pregnancy, childbirth and breastfeeding. The clay models showed every kind of physiologic and pathologic foetal presentation inside the maternal uterus. The three-dimensional perspective of these models replaced the two-dimensional of the drawings that illustrated the books and the atlases of medicine, giving

[5] Semenzato 1979.

[6] Morgan 1907.

[7] Tergolina 1936.

a view and a handling much more real.[8] The collection still belongs to the Department of Women's and Children's Health of Padua University.

Before the foundation of the Museum of Pathological Anatomy in the second half of 1800, Padua Medical School owned some pathological collections preserved in different buildings around the city. A significant example was the ophthalmic waxes held by the Ophthalmic Clinic until 1971 and then passed to the Institute of history of medicine. The collection is composed of two different units: one made by Johann Nepomuk Hoffmayer (†1863) from Wien and the other by Pietro Gradenigo (1831-1904) from Padua. The Hoffmayer's waxes were 32 models made in Wien and donated to the Ophthalmic Clinic of Padua in 1819-1821, they were created in a period of evolution of both medical specialties and organ pathology, which brought morbid organs at the centre of medical investigation. The models represent the typical eye diseases of the period, in particular those affecting external parts, which could be investigated without the need for specific instruments devised for the observation of the inner and posterior anatomy of the eye, at that time not yet available.[9] The Gradenigo's waxes, made between 1884 and 1889, were 18 and showed different eyes diseases, such as neoplasm and tenonitis, and ophthalmologic surgical operations, such as some interesting cases of blepharoplasty.[10]

Regarding the pathology, there are reports of an "anatomical cabinet" in Padua from the early years of the XIX century, based on the request of the successor of Morgagni, Leopoldo Marco Antonio Caldani (1725-1813). Francesco Luigi Fanzago (1764-1836), owner of the first chairs of Pathology and Forensic Medicine in Padua (1806), was the founder of a pathological cabinet, where he kept specimens of his own preparation. The first items in this cabinet came from the autopsies made by Fanzago himself, which he described as "The first elements of our cabinet, since I was delighted to deposit them inside it, no longer regarding them as belonging to me, but to public domain".[11]

This collection increased as further items were added to it, either from the hospital and various hospices or from other colleagues or friends of Fanzago like Pietro Sografi (1756-1815), Caldani or Vallisneri, such as the

[8] Premuda 1958.

[9] Zampieri et al. 2018.

[10] Zampieri & Zanatta 2013.

[11] Fanzago 1820.

collection of kidney stones from the Natural Sciences Cabinet of Vallisneri himself. Fanzago continuously insisted on the importance of gathering and presenting an anatomical pathology collection, to the point where, in order to convince doctors and surgeons to send him examples of diseased members or organs, he directly petitioned the government to encourage the scientific establishment to collect conserved preparations of medical and educational interest. This interest impelled Fanzago to keep adding to his collection: "Despite the difficulties encountered up until now, I nevertheless have the satisfaction of having filled four cupboards with excellent quality pieces that were of notable value for public education".[12]

Thanks to the Professor of Anatomy Francesco Cortese (1802-1883), the pathological collection housed in the antechamber of the anatomical theatre not only grew in resources through the addition of items previously prepared by him in Venice, but the spaces devoted to housing it were enlarged and improved, because by 1844 the location was judged "Already too small for the number of preparations it contained, which in the six years since the appointment of Professor Cortese has grown to over five hundred".[13]

A particular collection has to be mentioned for its originality: it is a series of eight skulls still preserved in the Hall of Medicine at Bo Palace, near the old anatomy theatre built in 1545. It is said that some famous professors of the University of Padua donated their bodies to medical science, and the skulls were from these bodies. Among the eight skulls, there are five Padua University Rectors: Pietro Luigi Mabil (1752-1836), Stefano Gallini (1756-1836), Antonio Meneghelli (1765-1844), Salvatore Dal Negro (1768-1839), and Floriano Caldani (1772-1836), who was the author of one of the most admired 19th century human anatomy atlas. Some of them were famous physicians, such as Santorio Santorio (1561-1636), who invented revolutionary instruments to measure body temperature and pulse frequency, Giacomo Andrea Giacomini (1797-1849), and Bartolomeo Signoroni (1796-1844), eminent surgeon. The last of the series is Carlo Conti (1802-1849), mathematician. Francesco Cortese, professor of medicine and Rector of the University, started this personal collection of colleagues' skulls, so that he could make his own detailed studies on phrenology. The myth originates because these skulls

[12] Ibidem.

[13] Tosoni 1844, p. 127.

were placed in a Medical Museum, and served for phrenological investigations during the 1800's. A recent multidisciplinary research published in History of psychiatry,[14] showed what is behind this myth: even if nobody of these professors explicitly donated their body to science, we can say that only nowadays this implicit donation serves the purpose of scientific investigation.

But the final passage from Cabinet collection to Museum came about thanks to the arrival in Padua of Lodovico Brunetti (1813-1899), a young assistant of the famous pathologist Karl von Rokitansky (1804-1878) in Vienna. Brunetti was called to the University of Padua in 1855 to occupy its first chair of Pathological Anatomy and to direct the new Institute of Pathological Anatomy, just adjacent to the Hospital "Giustinianeo", where the former convent of San Mattia was. Brunetti held also the chair 1855 to 1887 and during this period, he introduced in Padua the classic tradition of pathological anatomy, the one that was headed up by Rokitansky based mostly on morphological studies of the organ and on the analysis of macroscopic lesions.[15] Brunetti revolutionized the Padua medical school because he strongly wanted to create a Museum of Pathological Anatomy inside the institute, so his students could study and touch with their own hands the pathological specimens. Brunetti in 1881 wrote: "In my school I'm very demanding, but in what? The rooms of my assistants and mine are very simple. I'm demanding in the anatomical theatre and in the museum".[16]

A first instalment of items for the future museum was consigned to Brunetti by clinical personnel: roughly three hundred pathological preparations, including some reliquaries by Morgagni) preserved in alcohol or dried. Unfortunately, Brunetti felt that these preparations were not suitable for teaching purposes:

> I studied them, redid them and reduced their number to about one hundred and thirty. The rest I consigned to the earth, and who can know how great was the sacrilege I committed, or how far I dishonoured Morgagni's spirit! But I beg forgiveness: I abhor uncertainty.[17]

[14] Zanatta et al. 2016.
[15] Zanatta et al. 2015, pp. 9-48.
[16] Brunetti 1881, p. 13.
[17] Ivi, p. 16.

From this point of departure, in the early 1870s Brunetti founded the Museum of Pathological Anatomy, which soon expanded with the addition of items prepared by Brunetti with a new method called tannisation. He developed this preservation procedure on account of an anatomical pathologist's need to create preparations "quickly, completely, economically"[18] while also ensuring enduring preservation. So Brunetti patented this system, which consisted of four phases: blood removal, fat removal, tannisation and drying. These operations were carried out either by immerging the specimen in preservative liquid or by injecting this through the arteries and veins until it penetrated all the basic tissue. After this procedure, the remains were dried with hot compressed air.[19]

Over the years, the museum has continued to grow, thanks also to Brunetti's successors, namely Augusto Bonome (1857-1922) and Giovanni Cagnetto (1874-1943): between them, these three men are responsible for most of the present collection, which was further boosted in the late 1960s by a large number of specimens relating to heart diseases.[20] Originally, the collections of the Padua Museum were arranged inside glass displays with a wooden framework: fine to look at but not so practical. Today, after renovations carried out in the 1970s, the displays are distributed through 28 large aluminium-framed glass structures, subdivided according to the organs displayed, the parts of the body where they were located and the type of pathology. Most of the items are contained in glass jar, preserved in alcohol or formalin, but some were mummified by Brunetti during his time at the University. Today, the Museum of Pathological Anatomy contains over 1300 specimens, which on account of their rarity and the variety of pathologies represented, make it one of the most important and valuable of its kind.[21]

Among all the specimens of the Museum of Pathological Anatomy of Padua University, there are two very particular for their story: the "Punished suicide" and the "Situs inversus viscerorum". The Punished suicide, preserved in 1863 by Lodovico Brunetti using his own tannisation method, portrays a girl aged eighteen, a seamstress, who was found drowned on the banks of the river which at the time ran beside the rear façade of the

[18] Ivi, pp. 25-43.
[19] Zampieri et al. 2011-2012.
[20] Zanatta et al. 2015, pp. 9-48.
[21] Cenzi et al. 2016.

Justinian Hospital and today runs underground. Local chronicles at the time described the event as an act of suicide caused by amorous delusion.[22]

During the autopsy, Brunetti made a plaster cast of the girl's face and upper bust. After this, he peeled away the skin from her face and neck, scoured the flesh with sulfuric ether and then treated it with tannic acid to preserve it from putrefaction. He applied the resulting tissue over the plaster cast, where the girl's features had been reproduced with the addition of glass eyes and plaster ears, while her shoulders were covered by a light lace fabric.[23]

In order to hide the gashes on her skin, caused by the hooks used to drag the corpse from the water, Brunetti had the idea of making this exhibit an allegory representing the punishment reserved in hell for those guilty of the heinous crime of suicide. He placed some wooden branches on her chest, and then entwined them with tannised snakes, placed to hide the wounds while seemingly poised to devour the girl's face. Brunetti proudly gave this 'artistic anatomy' exhibit the title of "La Suicida Punita". In 1865 Brunetti sent a celebrative manifesto of this work to Florence, dedicating it, along with his Symbol of Rational Medicine, as a homage to the six hundredth anniversary of the birth of Dante Alighieri (1265-1321). In 1867, both exhibits, together with various other tannised organs and body parts, were accepted for display in the Paris Universal Exposition. As a result, Brunetti was awarded the Grand Prix in the Arts and Professions section, for his exhibits and his innovative method of preserving bodies.[24] The Punished Suicide attracted great attention and admiration. In the booklet, which accompanied Brunetti's prize-winning exhibits, the pathologist proudly described how the girl's parents had complimented him for the precision shown in reconstructing their daughter's features. An extraordinary case history, without a doubt, reminding us of the enormous difference between our own attitudes to death and the dead, and those of just 150 years ago.

The "*Situs inversus viscerorum*" is the other unusual specimen. It is a tannised mummy dated 1915, consisting in the bust of a young woman who died at the age of 20 of salpingitis and tuberculous peritonitis. The salpingitis – an infection of the Fallopian tubes – was a complication in

[22] Zampieri et al. 2011-2012.

[23] Ibidem.

[24] Caffè 1867.

an infective peritonitis caused by the tuberculosis bacillus, still widespread in the early 20th century in Italy and Europe. An autopsy revealed a *situs inversus* of the viscera with dextrocardia.[25]

The term *situs* is used to indicate the position of the heart and the viscera. *Situs solitus* refers to the usual anatomical position, while *situs inversus* indicates a reversed 'mirror-image' position. In *situs inversus*, the morphologically right atrium is found on the left and the morphologically left atrium is on the right. The normal pulmonary anatomy is also reversed: the left lung has three lobes and the right lung two. The liver and gallbladder are on the left, the spleen and stomach on the right. The remaining gastrointestinal structures also present mirror-image versions of their normal positions. The first complete description of a *situs inversus* was published in 1788 by Matthew Baillie (1761-1823) in the Royal Society's scientific magazine Philosophical Transactions.[26] *Situs inversus* with dextrocardia, or *situs inversus totalis*, refers to situations where the heart in situated on the right-hand side of the chest. If the heart is in its normal position on the left, the diagnosis is sit*us inversus* with levocardia or situs inversus incompletus.

Situs inversus is caused by a defect in the chromosome X, with one case occurring every 8,000-10,000 people. 5-10% of *situs inversus* cases also feature congenital heart defects.[27]

The autopsy was carried out on July 13th 1915 by the then-director of the Institute of Anatomical Pathology Augusto Bonome, who opted to mummify the body in order to preserve it in the Museum. To do so, he used the "tanninisation" method patented by his predecessor Lodovico Brunetti. Given that the internal organs were left intact, the autopsy did not reveal other congenital malformations, cardiac or otherwise. The cause of death, as we have seen, was pronounced as salpingitis and tuberculous peritonitis.

A recent CT scan carried out on the girl's remains revealed a muscular defect in the interventricular septum, 0.5 cm in diameter, plus widespread calcific deposits on the visceral pericardium and the aortic wall, caused probably by a previous pericarditis of tubercular origin.[28]

[25] Zanatta et al. 2014.

[26] Baillie 1788.

[27] De Tommasi 1980.

[28] Zanatta et al. 2014.

Conclusion

Nowadays, the whole collection of 1307 elements is divided in apparatuses and within each apparatus, there is a further division according to the pathology. This classification has allowed us to analyse which disease are more frequently represented in some apparatuses. Inside the collection of the pathological anatomy museum, the skeletal system is the most represented with about 250 skeletal elements (20% of all samples) kept in liquid or dry. Among these, there are 55 skulls cup of different age and disease, all removed during autopsy. The digestive system with its 188 specimens is second, followed by urinary system (117), teratology (108), respiratory system (107), cardiovascular (106) and nervous (105) systems, male and female genital system (respectively with 58 and 43 exhibits), liver (57) and integumentary system (55). Finally, the wax models and the organs with few specimens, like the spleen, the thyroid, the thymus and the eyes, have been included into the miscellany.

The inflammation and malignant tumours are the most frequent pathologies among the museum's specimens, respectively with 28% and 25%. Benign tumours instead represent 11% of cases, while circulatory disorders 6.5% and organ malformations only 5.5%.

Finally, there are the cysts with 3.5% and the regressive alterations with 3%, the remaining 17.5% is included in the pathologies of other nature, which are not among the ones already mentioned. In more detail, there are several examples of inflammations both in the cardiovascular and respiratory systems, in greater numbers than other diseases: inflammations are 69% of diseases among the cardiac specimens and 52% among the respiratory ones. Regarding the digestive, urinary and integumentary systems, the malignant tumours are the most frequent, respectively with 34, 37 and 27%. On the contrary, benign tumours are very frequent in the nervous system with 42% and in the female genital system with 35%. The specimens preserved with the tannization are 41. Moreover, inside the collection there are 28 heads, fixed in formalin or tannized, while the whole bodies are 88, lots of them belonging to the teratology.

Thanks to Lodovico Brunetti, Augusto Bonome and Giovanni Cagnetto, the dual function of Museum-Institution and Museum-Laboratory has been preserved and developed in Padua over the years. Thus showing that the museum is a modern teaching instrument, indispensable to the training of pathology students and researchers and also important to satisfy the interest of non-specialist visitors. The Museum also illustrates the presence of various pathologies in Padua region over the centuries, revealing both the progress of the medicine against disease, from Morgagni to the present day, and the contribution to the study of the lifestyle of population in the area. The museum also allows to preserve a material archive, a kind of "biobank", a source of valuable visual and structural information about the past and present diseases.

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Roberta Ballestriero*

THE SCIENCE AND ETHICS CONCERNING THE LEGACY OF HUMAN REMAINS AND HISTORICAL COLLECTIONS: THE GORDON MUSEUM OF PATHOLOGY IN LONDON

Ethical issues on storing and exhibiting human remains

It comes as no surprise that, in this century, the living have some moral duties with regards to the dead, especially in the scientific environment in the case of the display of human remains for the purposes of education, research and study.

Many museums host, in their collections, more or less ancient human remains coming from different periods and countries, and science museums particularly have a long tradition of the display and storage of real specimens. Sometimes, however, one of the most troublesome aspects is the lack of information with regards to the source of the cadavers, the history and the provenance.

Under the current legal system of many Western countries, the burial wishes of the deceased are carried out by family and loved ones[1]. Bearing in mind the ethical issues concerning the person that these remains once were, it's our responsibility now, at least, to utilise human remains in an appropriate context keeping and displaying them respectfully.

The topic is currently a source of heated debates especially as we are witness to the rise of popular travelling exhibitions such Bodyworlds, where skinless corpses are displayed, often frozen in 'artistic' poses. In this environment there is, perhaps, a thin line between education and entertainment and the risk is sometimes that public curiosity and attracting audiences prevail over the didactic purposes.

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[1] Deathrigde 2017.

DOI 10.48255/M.9788891320186.06

With regards to the treatment of human remains in the case of personal identification, Licata and Monza recognised two conflicting moral opinions: "on the one hand, the manipulation of the ancient skeleton during the study phase and museum display is seen as a form of violation of the individual to whom the remains belong, while on the other, the analyses aimed at personal identification in forensic cases are necessary for the restoration of the human rights of an individual."[2]

The last few decades have seen a change of attitude towards the storage and display of human remains and what, in the past, was perfectly acceptable under the anthropological point of view is nowadays ethically debatable. Many indigenous communities, for example, have requested the return of their ancestors leading to the repatriation of human remains from museum collections. For example, since 1996, over 1000 indigenous remains were given back to Australia and New Zealand following an agreement with the UK and Australian governments.[3]

In 2006 the British Museum in London returned two Tasmanian Cremation Ash Bundles to the Tasmania Aboriginal Centre and, in 2008, some Maori bone fragments and worked bones to Te Papa Tongarewa in New Zealand.[4]

This issue in Britain is very much perceived and widespread at the museological level, also because a census showed that approximately 61,000 human remains are preserved in 132 institutions.[5]

As mentioned earlier, in recent years, feelings towards the use of human remains started to change in Great Britain. Many cases such as the sad story of Charles Byrne, the "Irish giant", attracted public indignation and the desire to listen to his last wishes. The skeleton of the "Irish giant", a centrepiece of the Hunterian anatomical museum in London, run by the Royal College of Surgeons, was of an 18th century man who had a genetic form of gigantism that caused him to grow to more than 2.31 metres tall. Before dying at the young age of 22, Byrne asked his friends to ensure he was buried at sea in a lead coffin because he did not want to end in a medical establishment as in fact happened as his skeleton appeared in John Hunter's private collection four years later.

[2] Licata & Monza 2007, p. 315.

[3] Deathrigde 2017.

[4] The British Museum, *Human remains: Policy and governance,* 2005.

[5] Monza 2014, p. 243.

For the last 200 years it was kept in the exhibition for "educational and research value", this being the reason why the Hunterian Museum rejected calls for the skeleton to be taken off display, but in recent years the museum has come under increasing pressure to honour the Byrne's final wishes to allow the remains to be given a respectful burial.[6]

In the British panorama, the sensitive, ethical issue of handling human remains has led to the release of a document in 2005 by the Department for Culture, Media and Sport (DCMS), outlining a code of practice for the handling and displaying of human remains that ensured that they were no longer treated simply as objects. According to the: "Guidance for the Care of Human Remains in Museums", "because of their origin, human remains should hold a unique status within collections, this puts particular responsibilities on the museums in the way they are acquired, curated and displayed"[7].

Unlike other countries, Great Britain has established a series of practices to deal with the ethical nature of the removal, storage and use of human tissue.

September 1st 2006 marked the enactment of the new Human Tissue Act (2004) legislation which replaced the Human Tissue Act 1961, the Anatomy Act 1984 and the Human Organ Transplants Act 1989 as they relate to England and Wales, and the corresponding Orders in Northern Ireland.[8] With regards to the Codes of Practice and Standards, The Human Tissue Authority's (HTA) regulatory remit is defined in the Human Tissue Act 2004 (HT Act). Covering England, Wales and Northern Ireland, The Human Tissue Act 2004 established the Human Tissue Authority to regulate activities concerning the removal, storage, use and disposal of human tissue.[9]

The need for new legislation arose from a violation of the previous Human Tissue Act 1961 with the so called 'Alder Hey organ scandal', which first came to light in 1999 when it emerged that hearts and other organs of hundreds of children who died at Bristol Royal Infirmary had

[6] Devlin 2018.

[7] https://www.britishmuseum.org/sites/default/files/2019-11/DCMS-Guidance-for-the-care-of-human-remains-in-museum.pdf p. 8.

[8] *www.odt.nhs.uk/odt-structures-and-standards/regulation/the-human-tissue-act-2004.* NHS Blood and Transplant Organ Donation and Transplantation clinical website, *The Human Tissue Act 2004.*

[9] Ibidem.

been kept without their parent's consent. A major scandal emerged soon after as it became clear that this practice went back decades: Birmingham's Diana Princess of Wales Children's Hospital and the Alder Hey Children's Hospital, in Liverpool, had been harvesting organs and tissues from the babies who died at their hospitals between 1988-1996. Apparently, thousands of organs taken at post-mortem examinations, often without the parent's consent, were stored by Professor Dick van Velzen, a Dutch pathologist, who worked at Alder Hey between 1988 and 1995.[10]

In 2001 Alan Milburn, the secretary of state for health at the time, announced to the House of Commons that the 1961 Human Tissue Act would be reformed "to enshrine the concept of informed consent." It was this central issue, in fact, that mostly concerned the public; the removal, storage and use of organs and tissues from adults and children without proper consent.[11]

The enactment of the Human Tissue Act 2004 has had a significant impact especially for examination and retention of human tissue for scheduled purposes such as research, transplantation, education and training; all these activities must be documented following certain procedures creating many implications for Clinical researchers, Pathologists, Anatomists and Surgeons.[12]

This toughening of controls has perhaps also dictated the decision, for some museums, to be open to the public or not. Additionally, "fake" skeleton decorations in tourist attractions that were subsequently discovered to be real human remains were removed from public display.

One such example was the case of the London Dungeon, a tourist attraction and interactive experience in London's South Bank that was opened in 1975. It recreates gory and morbid historical events and is decorated with skeletons and torture devices. In 2011, they discovered that a partial skeleton, nicknamed Kate (referring to the model Kate Moss), exhibited hanging in a gibbet cage was real and may have been on display since the opening. "Kate" was carefully analysed by an expert in the field, Mr William Edwards, from the London Guy's Hospital Medical Museum, who confirmed they were real human remains put together in the 1950s. The authentic skeleton, and another one nicknamed "Twiggy"

[10] Hunter 2001.

[11] Ibidem.

[12] Ibidem.

(referring to the model Twiggy - Lesley Lawson/Hornby) had to be removed from the attraction as the London Dungeon faced a fine, because displaying a real skeleton less than 100 years old requires a £2000 a year license from the Human Tissues Authority.

A British example: The Gordon Museum of Pathology in London

William Edwards is the curator of the Gordon Museum of Pathology, one of the largest pathology Museums in the world and one of the few medical Museums in the country that continues to accept new specimens to document new and emerging diseases.

The Gordon Museum is an independent department now affiliated to the Faculty of Life Sciences & Medicine at the King's College of London and its primary function is medical education at both undergraduate and postgraduate levels.

It provides a range of services and functions to the School of Medicine training medical, dental and biomedical students and professionals to diagnose disease and supports the studies of over 9,500 current healthcare students. It is the largest teaching medical Museum in the UK and has a growing collection of approximately 8,000 pathological specimens, the oldest dating from 1608[13].

The Museum is fully licensed by the Human Tissue Authority (HTA) and operates under the Human Tissue Act legislation (HT Act) which is a requirement of institutions holding human material.[14] As its main purpose is medical education, the museum is not open to the general public but it is at the service of the "Medical Public" of Kings College London, the associated Hospital Trusts and even welcomes national and internationals visitors in the medical/scientific field.

The HT Act makes consent a legal requirement for the storage and display of human material where it is less than 100 years since the person's death. The activity of public display was not covered by statute before the HT Act. Prior to this, there was no restriction on the display of human bodies or material of human origin.

[13] https://www.kcl.ac.uk/gordon

[14] https://www.legislation.gov.uk/

A key principle of the HT Act is that all human bodies and materials of human origin within its scope should be treated with respect and dignity. In relation to the public display of human material, this principle applies both to those showing the material, and to those viewing it. The ethical issues raised by the display of human materials acknowledges their unique status within museum collections and the special responsibilities placed on those who acquire and display them.

As mentioned previously, there are many issues related to the exhibition of human remains, therefore, it is a choice to be open or closed to the public and the Gordon Museum is only open to the medical public in the wider sense.

It is very important to underline that all the specimens present are donations (and it is worth mentioning that some of the donors are still alive) so, even if they have to be used for education purposes, they have to be treated with respect and dignity. Owners gave permission to use the pieces for teaching and therefore there is a moral agreement between the museum and the donors. Basically, the pieces have to be used for the right reason.

The Gordon Museum is arranged into four bays, each of which is divided into three floors. The two upper floors are galleries, which ring the bays and hold the specimen collections. The collection of specimens is organised by topic such as the same disease in different organs or the same organ with different conditions / diseases. Each licensed establishment is required to appoint a Designated Individual (DI) for their licence, who has a statutory responsibility under the HT Act to supervise activities taking place under a licence. The curator, Mr. William Edwards, is the Designated Individual of the Gordon Museum. He has a statutory duty to ensure that the bodies in their care are treated with dignity and respect.

For all these reasons, the strict rules of the Gordon Museum do not allow anyone to take pictures or videos. Also, medical artists are allowed to draw in the museum with the exception of certain specimens such as foetuses, genitalia and forensic specimens. The latter are excluded because some of them are 'cold cases' which the police may still need to use in investigations (at present there are 5 such 'cold cases' at the museum).

Although the first collections date back to 1826, the actual Gordon Museum was opened in the current location in 1905 and today hosts a number of historically important medical collections.

They include some rare specimens and artefacts by Thomas Hodgkin (1798-1866), Thomas Addison (1795-1860), Richard Bright (1789-1858) and Sir Astley Paston Cooper (1768-1841). Also, on display in the museum are the pre-operative paintings by the Chinese painter Lam Qua (1801-1860) and the anatomical, dermatological and pathological wax model collection of the sculptor Joseph Towne (1806-1879), the first and the only anatomical ceroplastic artist known in the UK during the nineteenth century.

Historical collections at the Gordon Museum

In the Percy Roberts room of the Museum there is a collection of some 23 paintings by the painter Lam Qua[15]. He was both talented and prolific and was one of the most acclaimed portrait painters on the southern coast of China in the nineteenth century. He was the oldest pupil of George Chinnery, a British portrait painter. Chinnery, whose master was Joshua Reynolds, became the first British painter to settle in China.

Lam Qua became an expert in portraiture, a style almost absent from Chinese tradition. The Rev. Dr Peter Parker (1804-1888) began working in China in 1834 as a medical missionary and took Lam Qua's nephew as an apprentice. In gratitude for Parker's work, the artist offered to paint Parker's most interesting cases. Lam Qua's only condition was: "As there is no charge for cutting, I can make none for painting".[16]

In fact, he painted the pictures for free according to Parker, in recognition of the hospital's decision not to charge the patients,[17] as well as in appreciation of Parker's hiring of his nephew as a student.

Initially, Parker may have thought of using the paintings as teaching aids for medical students. Additionally, visitors to the cantonal hospital report that there were paintings of patients in the waiting room before and after the surgery.

A prominent medical missionary, Reverend Dr Peter Parker was an American Presbyterian minister and physician who arrived in China in

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15 https://www.kcl.ac.uk/gordon/collection/models

16 Ibidem.

17 Cummings 2018.

1834, four months after graduating in medicine from Yale. In 1835, he opened a hospital in Canton, a southern province now called Guangzhou.[18] He gained such a reputation as a surgeon that it brought him thousands of cases. Among them were a large number of patients suffering from deformities or tumours of rarely seen and almost unimaginable size. It was these Chinese cancer patients that Dr Parker had Lam Qua paint using oils in the pre-photography period and which offer an insight into extremely serious diseases. Dr Parker used these paintings to promote the services of his hospital and to raise funds.

Disturbing, grotesque but also powerful, these mysterious and beautiful paintings exemplify the extreme and horrible aspects of a number of conditions and, in many cases, the full pathos of various pathologies. They are very interesting testimonies, illustrated with great skill at a time when knowledge in the field of pathological diseases were in an embryonic phase of development. These images constitute an invaluable resource in the history of medical representation.

Nowadays, most of the works are kept in the Peter Parker Collection in the Yale University Medical Historical Library and in the Gordon Museum, King's College, London. Parker donated twenty-three paintings to Guy's Hospital in London. In 1841, during his visit, he provided original descriptions of his patients.[19] A further 105 paintings can be seen at Yale, where Parker had completed a twin course in theology and medicine in 1834.

The museum hosts the anatomical, dermatological and pathological wax model collection of the sculptor Joseph Towne. Since the 18th century Europe witnessed the creation of entire collections anatomical models in different materials, intended to facilitate the education of students of medicine. In Italy, during the 18th century, the tradition of anatomical ceroplastics led to the creation of workshops first in Bologna and later in Florence, whilst in England the first serious attempt at introducing the art of modelling wax anatomical works was made by Towne. Apparently previous attempts had been made, although all anatomical wax models that had been exhibited had been imported from abroad[20]. Indeed, Italian workshops sold many anatomical models, often in a reduced scale, across Europe and overseas.

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[18] Ibidem.

[19] https://www.kcl.ac.uk/gordon/collection/models

[20] Wilks & Bettany 1892.

Towne worked at Guy's Hospital Medical School from 1826 until his death in 1879, a period of 53 years. In this half-century of work, it is thought that he created nearly a thousand medical models in coloured wax some of which were sent abroad to medical schools in India, Australia, Russia and America[21]. The beauty and accuracy of his works secured him a prize at the first International Exhibition of London in 1851[22]. Although he was also a skilful marble sculptor, Towne is best remembered as the great master of English ceroplastic art. Working in isolation and developing his own very distinctive style he was the creator of a great collection of anatomical, dermatological and pathological models.

An astonishing collection, his magnificent and brutally realistic waxes are faithful copies of the cadavers lying on the dissecting table. The models are extremely realistic and there is no attempt to hide the fact that the corpses copied, at that time, came from criminals condemned to death. In Great Britain, in fact, the government passed the Murder Act of 1752 which introduced the punishment, post-mortem for murder, of anatomisation and dissection. It allowed the College of Surgeons to obtain six criminal bodies a year for dissection.

The educational value of these antique scientific collections

Like the painting of Lam Qua, Towne's models are a very important part of the museum and are still useful for didactic purposes. Even the making of the artefacts betrays their main scope for which they were created. The dermatological collection, in particular, is made with thick wax and the models are robust and solid therefore suitable to be handled by physicians during teaching demonstrations and by students. The containers are often made of glass that resemble the vessels of human wet specimens, leading the viewer perhaps to confuse real and artificial anatomy.

Indeed, one of the fields in which possibly the use of wax has been unrivalled is the representation of pathological anatomy. Even today there is probably no other material which manages to reproduce the past

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[21] Ballestriero & Richardson 2014.

[22] Wilks & Bettany 1892.

and present pathologies of the human body in such a realistic manner. These models anticipate the role of photography in recording pathologies belonging to the past centuries.

Joseph Towne's earlier models were based on the dissections of demonstrator John Hilton while the dermatological moulages were the copy of exterior skin conditions of patients sent to Towne by Thomas Addison, the foremost authority on skin disease of his day. In London, in fact, all the dermatological moulages are derived from patients treated at Guy's Hospital.

Thomas Guy founded, in 1721, the Guy's Hospital that was originally established as a place to treat the "incurables" that St Thomas's Hospital, and other establishments refused to accept. The hospital was known for the care of "the incurably ill and the hopelessly insane".

These collections were created for research and didactic purposes, information of the individual patients is still preserved, each of the specimens is fully documented and all the relevant details of the condition and medical history of the patient are on show with the specimen. This makes the museum extremely easy to use as in most of the cases the medical history is presented with the drawings and the three-dimensional models, making this an invaluable source for medical students.

These waxes, obtained with the technique of 'moulage'[23], are still used for teaching after 190 years and up until the nineteen seventies the dermatological models were often used in classes. Since then, they were used more systematically by the dermatologists at the Gordon Museum and, until recently, on Mondays some dermatologists taught classes at the museum using Towne's waxes.

The scientific and didactic value of these preparations is unquestionable; the creation of entire anatomical wax collections, in fact, is also designed for the preparation of medical students. The possibility of studying full size, almost anatomically perfect anatomical wax preparations was certainly a valid help and support for anatomy manuals accompanied by illustrative drawings, which could be relatively difficult to interpret due to their two-dimensionality. The convenience of having accurate and realistic pathological models readily allowing the detailed

[23] According to the Oxford Dictionary 'Moulage' is a cast or impression, especially of a person or a part of the body; the process of making a cast or taking an impression.

study of the disease throughout its various stages meant that the use of moulages rapidly spread throughout Europe[24].

At the Gordon Museum students were incoraged to interact with the wax moulages as if they were real patients, and only afterwards they were able to see patients in clinic. In the past, it has been noted that sometimes students seemed to prefer using the wax preparations instead of studying the actual patients: they could spend more time observing the features of the disease without disturbing the real patients and, also, the wax models are not contagious. As Jonathan White, Honorary Senior Lecturer at KCL suggested, students enjoy role-playing clinical cases in a friendly environment. It has been observed that, unlike those who use only books and two-dimensional images, the students who study using the dermatological models subsequently show greater empathy towards patients[25].

The main idea behind this practice was also to enhance specific skills in health-care students and improve social cognitive abilities, especially empathy. Using artworks as 'patient surrogates' is an ethical way to practise these skills[26], with the added benefit of not disturbing sick patients.

It would be interesting to undertake further investigation on this practice in order to demonstrate the efficacy of the use of moulages in teaching, however the positive results so far underline the importance of these artefacts and the reasons why these antique collections may still be relevant today.

In this period scarred by the Covid-19 pandemic we are increasingly realising the paramount importance of studying emerging diseases, especially highly contagious ones. Also, past years have witnessed the resurgence of long forgotten diseases in the Western world, making these models up-to-date and still extremely useful. The English collection of the Gordon Museum is not only interesting from a historical point of view but it is still relevant to third world countries where some of the diseases, represented by the moulages, are still observed.

Nowadays, thanks to these models we are still able to see, in three dimensions, diseases such as smallpox, the first disease to have been fought on a global scale and that was officially declared eradicated on

[24] Ballestriero 2007.

[25] Ballestriero & Edwards 2017.

[26] Braveman 2012.

May 8, 1980, by the 33rd World Health Assembly. This disease caused repeated large-scale epidemics and in the 18th century smallpox was the cause of death of more than 400,000 people in Europe each year[27]. Eradication of smallpox is considered the biggest achievement in international public health to date[28] and these moulages are still here to remind us this success.

From 2020, the surveillance of congenital syphilis has become part of the 'Infectious Diseases in Pregnancy Screening Programme' where data are being collected to allow the infectious diseases in pregnancy screening (IDPS) to monitor performance, review all positive cases and identify new areas for further audit and research. In 2017 the UK witnessed a 20% increase in cases of syphilis compared to 2016 with more than 7,000 cases reported to Public Health England in 2017[29]. In 2018, according its *Health Protection Report* there were 7,541 diagnoses of syphilis, a 5% increase from 2017 (primary, secondary and early latent stages: 5%; from 7,149 to 7,541)[30]. Even if most cases of syphilis can be cured with antibiotics, the moulages are a dire warning of how serious the disease can become if left untreated.

Other infectious diseases that had appeared to be under control are also becoming more prevalent, perhaps in part due to the continued weakening of vaccination coverage due also to the surge of Anti-Vax movements. According to the World Health Organization, in 2018, over 82,500 children and adults in the WHO European Region were infected with measles, and 72 people have died. To put this into context, the number far exceeds the annual totals for every year this decade; the number of cases in 2016 was at its lowest with 5273 and at its highest in 2017 with 23,927.[31]

Even more recently, in the United States the number of cases of measles in 2019 has surpassed the highest number on record since the disease was declared eliminated nationwide in 2000.[32] According to CNN's

[27] Riedel 2005, pp. 21-25.

[28] www.cdc.gov/smallpox/history/history.html

[29] www.bbc.com/news/health-44368741: BBC News, 5th August 2018.

[30] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/806118/hpr1919_stis-ncsp_ann18.pdf: Health Protection Report Volume 13 Number 19, 7 June 2019. Advanced Access report published 4 June 4th 2019.

[31] Copenhagen, Denmark, August 20th 2018.

[32] https://edition.cnn.com/2019/04/24/health/measles-outbreak-record-us-bn/index.html

analysis of data from state and local health departments, there have been 681 measles cases across 22 states[33]. It is easy to underestimate the seriousness of measles but, in fact, the mortality rate is 3 in every 1000[34].

Nowadays, more than ever, these collections and, in general, science museums, are useful and relevant. As it used to be for centuries the arts, the sciences and medicine can work together toward learning, research and medical care. The presence of human remains in museums has meaning and is important because it contributes to scientific research in various fields. Exposing human remains today, however, also means dealing with various museological and museographic problems that go beyond purely scientific questions and are more in the ethical sphere.[35]

British museum policies have changed as a result of the debate on how to handle and house human remains and led to the establishment of a code of ethics and protocols. They have pioneered this new approach that began a trend that was followed by other European nations.

Science museums preserve an invaluable heritage but must also take into consideration the ethical issues of displaying and exposure of human remains. The Gordon Museum is a perfect exemplar of this approach but is also a remarkable example of productive marriage between art and science because generally collections such as dermatological wax moulages are more often kept only for historical or artistic reasons.

[33] Ibidem

[34] Galassi 2017, p. 74.

[35] Monza 2014, p. 241.

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Section 2 – Shaping *Scientia*: Case Studies of Early Modern Medicine, and Beyond

R. Allen Shotwell*

BETWEEN TEXT AND PRACTICE: THE ANATOMICAL INJECTIONS OF BERENGARIO DA CARPI

Introduction

In 1521 the surgeon and anatomist, Berengario da Carpi (1460-1530), reported on a pair of sophisticated anatomical investigations into the flow of urine he made by injecting water into different parts of the body.[1] Surprisingly little attention has been paid to Berengario's work, perhaps because it sits uncomfortably in the standard chronology of anatomical injections and physiological experiment. Most historical narratives of these subjects focus on the seventeenth century as the key era, physiological experimentation beginning with William Harvey and a sort of golden age of anatomical injections arriving shortly after. From that perspective, Berengario's work, which occurred a century before appears to be an outlier, a very early precursor of things to come.[2]

In this article I attempt to provide a different context for Berengario's work, one that looks to his immediate predecessors and contemporaries for information about why he sought to investigate the flow of urine and why he used injection to do so. In keeping with recent trends in the history of science and the role of experimentation, I employ two approaches for interpreting Berengario's work – one textual and one practical. The context in which Berengario reported his injection work, a commentary on the fourteenth-century work on anatomy by Mondino (cca. 1270-1326), was part of a changing approach to anatomical writing in the early sixteenth century and provides insight into why he described the in-

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[1] Berengario 1521, p. 259r.

[2] Cunningham 2003, pp. 51-76; Cole 1917, pp. 285-343.

DOI 10.48255/M.9788891320186.07

jections he made, while the questions he explored and the injections techniques he used to explore them were largely drawn from the traditions of surgical practice.

Situating Berengario's injections in these twin contexts serves to illustrate a particular view of the history anatomical study in the early sixteenth century, one that not only doesn't look to the future for an interpretative framework but also considers renaissance anatomical study in the context of practice rather than theory. Berengario's injections highlight the fact that anatomy played an active and important role in medical and surgical treatment in the early sixteenth century and that it was subject to discussion and debate within that context despite the standard interpretation of the history of anatomy which typically assigns little or no practical value to anatomical knowledge and often presumes it to be stagnate prior to the middle of the sixteenth century.[3]

Berengario and his injections

Berengario's place in the history of anatomy has long been established as one of the earliest figures to advocate for knowledge from dissection and as the first to deny the existence of certain structures on the basis of his own dissection experience.[4] From 1502 to 1526, Berengario held a chair in surgery at the University of Bologna. A son of a surgeon, he first learned his craft from his father, accompanying him as he treated patients, before attending Bologna for his formal education. As a surgeon, Berengario had a distinguished reputation, and in addition to his work on anatomy, he published a book on the treatment of head wounds in 1517, the *Tractatus perutilis et completus de fractura cranei*.[5]

Berengario reported on his injection experiments in a monumental commentary on the fourteenth-century text devoted to anatomy by Mondino de Luizzi, also a professor at Bologna, the *Anathomia*. Mondino's text was still very much a part of the medical school curriculum in the sixteenth century. At Bologna and many other schools, it was the text used to accompany the public demonstrations of anatomy conducted annually for medical students. Berengario's commentary praised Mondino's brevity and judgement but greatly expanded on the original content and corrected many of its assertions. In it Berengario described two injection experiments – one he performed in an attempt to settle a question about the structure of the kidney and how it performed its function of separating urine from blood and one to investigate the way a fetus urinated, pursued after Berengario identified discrepancies between Galen's description of fetal anatomy and his own personal observations.

The question of a kidney's internal structure and how that structure allowed it to perform its function was a matter of some dispute in the sixteenth century, and Berengario made it clear that he had employed injections to settle the questions involved. The focus of the disputed point was a filtering membrane inside of the kidney described by Mondino who postulated that it was the structure responsible for separating urine from blood. Mondino's suggestion was a new one, not derived from Greek or Arabic sources but based on his own observations.

As Michael McVaugh has shown, Galen described the kidney as having a natural faculty that attracted blood mixed with urine to it, but when it came to describing the exact process by which urine was separated from the blood in the kidney, he was less than clear. He was clear about how it did *not* work, objecting to a simple analogy with a sieve because that model required an explanation of how urine separation occurred in the kidney but bile separation in the gall bladder. For Galen, a simple sieve, which allowed smaller material to pass while holding back larger material, would allow both the urine and bile to be separated in the gall bladder before it ever reached the kidney.[6]

Mondino's suggestion of a membrane that strained the blood was widely repeated by later anatomical authors despite its lack of classical precedent and can be found in the early sixteenth century in works on anatomy by Alessandro Benedetti (ca. 1450-1512), Gabrielle Zerbi (1485-1569), and Alessandro Achillini (1463-1512) and, with some qualification, by Nicolo Massa (1485-1569).[7] There was, however, one objection to Mondino's claim, made in a fifteenth-century commentary on the *Ninth Book of Almansor* the *Practica* by Matteo Gradi (d. 1472). Gra-

[3] Carlino 1999, p. 2; French 1999, p.1.

[4] Lind 1975, p. 3; French 1985, pp. 54-61.

[5] Putti 1937, pp. 40-47; French 1985, pp. 43-49.

[6] McVaugh 2012, pp.103-137.

[7] Benedetti 1514, p. 21; Zerbi 1502, p. 34r; Achillini 1520, p. 7; Massa 1536, p. 31r.

di's objection was essentially a matter of medical practice. To him, the kidney's internal structure and its removal of blood from urine was linked to the medical symptom of blood in the urine. The standard treatment for that condition focused on repairing the kidney's natural faculty, Galen's explanation for the way the organ accomplished its task. If a filtering membrane was the way the kidney worked, then blood had to be result of damage to that membrane and the standard course of treatment would be ineffectual.[8]

Berengario cited Gradi's objection. In order to the settle the question of whether the Mondino's explanation was correct, he employed a contrived artificial test, an early modern procedure Evan Ragland has described recently as "making a trial" (*periculum facere*).[9] Trial-making examples can be found in medicine well before the sixteenth century, for example in medieval tests of the efficacy of certain medications, and as Ragland notes, the practice of making trials continued in sixteenth-century natural philosophy where the received wisdom about the medicinal properties of plants was often tested by contrived trials and where trials were cited as proof in deciding between competing descriptions.

Trials were also a part of anatomy where the precedent was first set by Galen, who described a trial involving a vivisection that he made to confirm his theory about the pulse and continued in the sixteenth century by Vesalius who employed the same procedure for the same purpose. Vesalius also performed other vivisections that he described using the phrase *periculum facere*, and while Berengario's interest in vivisection differed greatly from what is found in the *Fabrica*, it is worth noting that his second injection experiment (described below) also relied in part on a description of a vivisection experiment described by Galen.[10]

In the case of the kidney, Berengario reasoned that if the filtering process worked via a membrane, as Mondino had said, then water injected into it should flow out the ureters and into the bladder just as the urine did. However, when he injected a kidney with water introducing it into the vein leading into the organ, Berengario saw only a swelling on its surface which ultimately burst open when he injected additional water. Cutting open the kidney, Berengario saw some nipple-like structures

[8] Gardi 1520, pp. 317-326.

[9] Ragland 2017, pp. 503-528.

[10] Shotwell 2013, pp.171-197.

that might explain how the kidney worked, but he remained in doubt and suggested more experimentation was needed before an adequate answer to the question of how the kidney worked was possible.[11]

Berengario's second injection involved the process of fetal urination and arose from discrepancies he found between Galen's account of the fetus and his own observations. His first finding involved Galen's description of the umbilical cord as composed of two arteries, two veins and the "urachus", the duct by which urine flowed from the fetus to the sac formed by the *allantoic* membrane.[12] Berengario disagreed with Galen's description noting that although it may be true "sometimes" (*interdum*) he himself had never seen anything but a single vein (not two) when he dissected an umbilical cord.[13]

Berengario found another discrepancy in Galen's description of fetal urination. In the fetal dogs he had dissected, Berengario had discovered an opening in the bladder which was needed for urination to occur through the umbilical cord as Galen described, but he found no such opening in the bladder of a human fetus. The difference caused Berengario to speculate about the process of fetal urination and how that process might be affected by the differences in structure he found. He decided to investigate the question through injection.[14]

For this injection, Berengario referred to a passage in Galen's *On The Natural Faculties* where Galen described a vivisection experiment intended to demonstrate the role of the ureters, the bladder, the kidney and the spermatic duct. In Galen's experiment, the ureters of a live animal were ligatured, and, after a period of time, they became swollen with urine. When the ligatures were removed the bladder filled with urine, but before the animal urinated, Galen ligatured the penis and then

[11] Berengario 1521, p. 178r.

[12] May 1968, pp. 661-665.

[13] Berengario 1521, p. 259r: "Galen dicit quae in umbilico sunt duae venae: & ego non vidi nisi unam quando diligentissime anatomizaui. Sed interdum ego credebam duas venas esse in umbilico de quibus duabus credebam quae ad intra ventrem pueri efficeretur una sola quae vadit ad hepar. Quia credebam Galen (ubi supra). Tamen ego non inueni nisi unam venam in umbilico". Translated: "Galen says that in the umbilicus there are two veins, but even when I dilligently dissect, I see only one. And I believe that *sometimes* there are two veins in the umbilicus out of which I believe the two that [reach] beyond the belly of the fetus are formed into only one coming into the liver. Which Galen believes (see above). Yet I have discovered nothing but one vein in the umbilicus".

[14] Berengario 1521, p. 260r.

squeezed the bladder all over in order to show that the urine would not return to the kidney through the ureter.[15]

Berengario squeezed the bladder of a human fetus he was examining to see where the urine would go, but he observed nothing, no urine exited in any direction. Deciding that there was probably no urine present in the bladder of his subject, he then filled the bladder with water by injecting it through the penis. When he squeezed the bladder again, the water passed back out through the penis. Berengario then tried a second experiment. He injected water into the ureter from the kidney and tied the penis off to eliminate any possibility of missing a path for the urine to flow, making his procedure as close as possible to the one Galen described. This time when the bladder was compressed, the water had nowhere to go and remained in place.[16]

This time Berengario saw no ambiguity in his results. The human fetus did not urinate through the umbilical cord as Galen had said. His work had shown that the only path for the urine was through its penis. Since the fetal dogs he had dissected (which still had an opening in the bladder leading to the *urachus*) were not as far along in development as the human fetus on which he performed his injections. Berengario reasoned that Galen must have been talking about urination in earlier stages of fetal development.

Berengario's injections appear to be truly remarkable for their time. The issue of the kidney's operation and its internal structure was not thoroughly discussed again until Vesalius, nearly two decades latter although Massa described a modified form of Berengario's investigation and the investigations of its function by injection not until well after that.[17] Follow up investigations of fetal urination were an even longer time coming, and further anatomical injections are found primarily in seventeenth-century sources. Even the use of contrived trials to investigate open questions in anatomy seems to be a new idea in the early sixteenth century. All of which suggests that attempting to understand the context of Berengario's work is worthwhile.

One fruitful source for context proves to be the literature on medical and surgical practice of the late fifteenth and early sixteenth centuries.

[15] Galen 1916, p. 16.

[16] Berengario 1521, p. 260r.

[17] McVaugh 2012, p. 137.

As we have already seen, Matteo Gradi's commentary was key to Berengario's understanding of the kidney, but Gradi's work and other works on medical and surgical practice also supplied details about the technique and procedures of injections that closely matched Berengario's investigations and also promoted the idea of investigating properties of the body using them. Before turning to those sources, however, it is useful to ask why the discussions about kidney structure and fetal urination appeared in Berengario's book in the first place.

The development of an investigative genre

Berengario's commentary was part of a shift in the structure of anatomical texts that occurred in the early sixteenth century. Works devoted exclusively to anatomy were relatively rare before the end of the sixteenth century and generally followed the same format as Mondino - short dissection manuals that focused on the steps followed in conducting an anatomical demonstration and on briefly describing the parts of the body commonly examined in that procedure.

In 1490, for example, Girolamo Manfredi (ca. 1430-1493), a prominent member of the medical faculty at Bologna , wrote on anatomy at the request of Giovanni Bentivoglio (1443-1508), the ruler of Bologna, who had attended an anatomical demonstration. What Manfredi wrote for Bentivoglio was, in effect, an updated version of Mondino. The anatomical details were essentially the same as Mondino's and Manfredi retained many of Mondino's instructions concerning how to dissect, although he added additional textual references and elaborated on some of the topics.[18]

Manfredi's contemporary at Bologna, Alessandro Achillini, also produced a work on anatomy, printed only after his death. Like Manfredi's book, Achillini's anatomy clearly followed the basic format of Mondino's handbook, updated with references to his own specific experiences including references to particular bodies that he had examined, identified by year. There were changes in the air however, and early in the sixteenth century two texts broke away from the dissection manual format. The first was written late in the fifteenth century by the Venetian physician,

[18] Singer 1917, pp. 79-164.

Alessandro Benedetti. Benedetti was not participating in the traditional medical school approach to anatomy but was instead writing as a humanist reformer who sought to cleanse anatomy of its medieval and Arabic influences. He still tied his approach to anatomical demonstrations, but he did not write in the same format as Mondino. For example, he largely dispensed with instructions about how to dissect, and he added content beyond the material included by Mondino. He also slightly modified the order of subjects.

In 1502, another kind of anatomical text was published by Gabriele Zerbi, the *Liber anathomie corporis humani*.[19] Zerbi had taught at several schools in Italy, including Bologna and Padua, and was clearly part of the schoolmen's approach to medicine, but his book on anatomy was not an updated version of Mondino's dissection manual, but rather, a fully-fledged and extensive discourse on the subject modeled on the kinds of books written on other medical subjects.

The contrast between the book Zerbi wrote and the book written by Mondino is immediately obvious in their relative sizes. While typical early printed versions of Mondino were slim books, printed in octavo, Zerbi's book was a folio, printed in two columns and running over 450 pages. Part of what made Zerbi's book so much bigger was its scope. While Mondino had largely confined himself to the aspects of anatomy seen in demonstrations, Zerbi discussed all the parts of the body including things like bones, nerves and the muscles given short shrift by Mondino and other topics hardly present in his work at all. Zerbi also included detailed discussions of broad anatomical questions like theories on generation, for example, where his discussion was so extensive that later in the sixteenth century it was extracted and printed as a separate text.[20]

Another addition made by Zerbi was the full textual apparatus of scholastic writing so that the core text was augmented by additions (*additio*), opinions and extended discussions carefully weighing the opinions of a variety of authorities and adding material found from experience. Zerbi also wrote an extensive prologue in which the definition, necessity and utility of anatomy were clearly laid out. He described the methods for obtaining anatomical knowledge and described the best

[19] Zerbi 1502.

[20] Lind 1975, pp. 23-41.

way to teach anatomy by emphasizing the importance of dissection. In another break from his predecessors, Zerbi also distanced himself from anatomical demonstrations, claiming they were inadequate for sophisticated anatomical study.[21]

Roger French has pointed out that Zerbi's work had an impact on Berengario's writing, and he sees Berengario's commentary as an attempt to bolster the reputation of Mondino and Bologna as the font of anatomical learning against Zerbi (who he presumably associated with Padua or Rome). Berengario certainly made extensive use of Zerbi's work. There are several places where Berengario basically repeated Zerbi's ideas, especially in his introduction. He also repeatedly referred to Zerbi's specific anatomical claims, often in order to refute them, but not always.[22]

When it came to the kidney, Zerbi had agreed with Mondino's idea of the filtering membrane and, as Berengario pointed out, claimed to have seen the membrane himself, *"dicit se vidisse"* and to be able to supply witnesses who had also seen it.[23] While other authorities had discussed the membrane idea, it was Zerbi who had most recently invoked confirmation of it by dissection, and, according to Berengario, it was "because of this discrepancy between Mondino, Zerbi and many other moderns" that he wished to see for himself and sought clarification of the kidney's function through injection. There seems little doubt that Berengario injected kidneys to test Zerbi's claim and reported his results in direct response to them.[24]

Recently historians have focused on shifts in the structures of texts such as the one that occurred with Zerbi as indicative of the changes in the role of empirical knowledge. Gianna Pomata, for example, has identified the epistemic genre of observation which began in the sixteenth century when both the word, observation, and the structure of texts subsumed under the category of *Observations* signaled changes in the role of knowledge from experience with the physical world. In Pomata's example from medicine, Amatus Lusitanus's (1511-1568) *Centuriae Curationum*, there were clear typographical signals of the change such as

[21] Shotwell 2015, pp. 1-18.

[22] French 1999, pp. 91-95.

[23] Berengario 1521, p. 164r: "Dicit tamen Zerbus qui in renibus est colatorium & dicit se vidisse & qui ille que vidit testimonium potest dare".

[24] Ivi, p. 174r : "ob quam dissonantiam Mundini & Zerbi & moturum aliorum modernorum".

when Amatus set his personal *curatio* in contrasting type and placed it in the spot once reserved for the words of ancient authority.[25]

The earliest example of anatomical observations, Gabriele Falloppio's (1523-1562) *Observationes anatomicae*, did not appear until some forty years after Berengario's commentary, but as Pomata observes, changes were afoot before the formal appearance of the term. I suggest here that one of these changes was a shift from dissection manual to full textual treatment of anatomy. The change was made most clearly by Zerbi who expanded the scope and treatment of anatomy to match the sorts of works written in other medical subjects while retaining the role of direct observation that was traditional to the dissection manual. In doing so, Zerbi opened the door for Berengario who often sought to correct his predecessor's claims and who, although he wrote in support of Mondino, saw the final arbiter of any dispute as the senses.[26]

A similar claim can be made about the connection between Berengario's work on fetal urination and Zerbi's book. In that case, Berengario was not attempting to resolve a dispute of recent authors or trying to decide between an opinion held by Zerbi and one offered by others, but he *was* working on a subject that, prior to Zerbi's book, had received very limited attention in anatomical texts.

Once again, Zerbi's extensive discussions of generation and embryology served as the launching point for Berengario's own efforts, but here Berengario seems to have been more or less unique in his empirical investigations of fetal anatomy. No other anatomical author in the fifteenth or sixteenth century that I have found describes dissecting a fetus to investigate its urination or any aspect of anatomy, even though the questions of generation and embryology were important topics in other medical genres and symptomatic of the growing influence of learned, male physicians in women's medicine more broadly. Unquestionably, there were practical constraints, as Berengario himself noted. Obtaining human specimens to dissect was nearly impossible, and fetal animals were typically substituted. [27]

While the changes in anatomical writing provided both the reporting venue and the impetus for Berengario's injection experiments, there was

[25] Pomata 2011, pp. 56-57.
[26] French 1985, pp. 43-49.
[27] Park 2006; Green 2008.

another key influence on his work, medical and surgical practice. It was Matteo Gardi's text on practice that provided the dissenting voice in the case of the kidney, as we have already seen, but Gardi's book and similar texts were also filled with the sort of injection techniques Berengario employed. Injection was both a method of delivering medication and for investigation.

Investigation, injection and medical practice

In 1472 Giovanni Matteo Gardi published his commentary on the *Ninth Book of Almansor*, a work that formed part of the surgical curriculum at Bologna. Gardi's commentary served an important role in bridging anatomy and therapy since it mixed anatomical material with material on a variety of remedies. Historians have already noted the importance of Rhazes (854-923) to Vesalius, but Gardi's commentary does not figure prominently in the standard narratives of the development in anatomy in the sixteenth century, even though it was in texts like Gardi's, devoted to issues of medical or surgical practice, rather than in books devoted exclusively to anatomy, where much of the anatomical writing before the sixteenth century can be found.[28]

It is only recently that historians have begun to recognize a connection between anatomical knowledge and medical and surgical practice in the renaissance. Recent studies have shown that in the sixteenth century physicians were clear about the way sophisticated anatomical knowledge informed diagnosis and treatment, and medical faculty worked to instill that fact into their students.[29] The place of anatomy in the fifteenth century remains to be thoroughly explored, but works like Gardi's, which combined anatomical knowledge with details about practice, enjoyed a wide circulation in the fifteenth century and continued to be reprinted in the sixteenth primarily because of their utility for a practicing physician.[30]

Gardi's text went through numerous editions in the fifteenth and sixteenth centuries. Its basic message was extended even farther by Marco

[28] Compier 2012, pp. 3-25.
[29] Stolberg 2018, p. 61-78; Stolberg 2017.
[30] MacClean 2009, pp. 87-106; Park 1985, pp. 191-198.

Gatinaria (1442-1496), one of his followers, who repeated much of his master's advice in his own work. One edition of Gatinaria was printed in Bologna by the same printer Berengario used, and Berengario was clearly familiar with the material having cited Gardi in his commentary.

In the chapter of his book devoted to the treatment of difficulty in urination Gardi began with an extensive discussion of the anatomy of the kidney, the passage Berengario cites, followed by a description of the anatomy of the bladder. As we have seen, he dismissed Mondino's filtering membrane because of the way it conflicted with medical treatment, but he also noted that it was not discoverable by experience (*experientiam non reperiant*) and that there was no mention of it in Avicenna.[31]

Gardi also wrote extensive about the use of injections. .A few pages after describing the anatomy of the kidney, Gardi described treating difficulty in urination by injecting medication into the bladder using a syringe. If difficulty of urination was caused by a bladder stone and if the stone could not be caused to pass by medication or diet, the physician could take a gold or silver syringe and inject water or a similar liquid into the bladder to expel the stone. In another, nearby, passage, Gardi also describes injecting through the penis. It is difficult to ignore the similarities between these procedures and the sorts of things Berengario did when he investigated his questions about kidneys and fetal urination, but it turns out that Gardi was not alone in recommending the use of injections in this way.[32]

Injections with syringes played a fairly prominent role in therapeutic writing in the fifteenth and early sixteenth centuries. They were used to deliver medications, but they could also be used to explore hidden structures. Like an anatomist, a physician or surgeon treating a patient was sometimes faced with the need for access to structures lying beneath the surface of the body. Sometimes that access was easily obtained by simply cutting open the body, but there were instances when this was not advisable, and in such instances probes and injections were used instead.

It is beyond the scope of this paper to provide an exhaustive account of the therapeutic injections in the fifteenth century, but in addition to Gardi's advice concerning stones, examples involving the treatment of fistula can also be found. Like most medical conditions, fistula were initially treated by medication and diet, but if those measures proved unsuccessful, then surgical interventions were necessary. Berengario's contemporary, the surgeon Giovanni Vigo (1450-1525), noted that treating fistula in the case of ulcers sometimes required cutting open the flesh if healing by diet alone was not possible. The mouth of the fistula could be widened by an incision to the point where medications could be inserted into the cavity. In certain cases however, cutting was not possible, for example when there were veins, arteries or ligaments in the way of the incision. In those cases Vigo advised that "the hollow ulcers can only be healed with sharp liquors cast into them with a syringe."[33]

Delivering medications into fistula or ulcers appears to have been a widespread recommendation. The injection process could also be extended to investigating the extent of such openings in the body. Another contemporary of Berengario's, Angelo Bolognini (fl. 1506-1517) repeated Vigo's idea of injecting medications for treatment but also described injecting to determine the extent of openings. According to Bolognini treating ulcers required the surgeon to first recognize the signs that formed the basis for his prognosis. Some signs were readily observable, the presence of swelling or of pain for example. Other signs, like the size and shape of a fistula, were "hidden and invisible to the senses" (*occulta & sensibus immanifesti*). When the physician needed to understand the hidden extent of a fistula, he could do so by carefully probing it or by injecting it with a liquid.[34]

Even these few examples from medical and surgical practice suggest that Berengario's injection experiments were not inventions of his own mind but rather an extension of the common methods and thinking of medical and surgical practice of his day. Berengario certainly knew the sources I have mentioned well. In addition to citing Gardi in his anatomical text, he cited Vigo in his surgical work. Indeed, Vigo and Berengario were well-known rivals who traded barbs in their books, while Bolognini taught surgery at Bologna alongside Berengario for a time.[35]

Injections were just one of a host of techniques employed by physicians and surgeons who sought to discover the properties of the body not immediately visible to the eye. Post mortem dissection of patients

31 Gardi 1517, pp. 318-321.

32 Ivi, pp. 317-326.

33 Vigo 1543, p. 126.

34 Bolognini 1506, sig. Bi.

35 Malgaigne 1965, pp. 194-196.

who died from unidentifiable causes were the most prominent example of such investigation, one that grew increasingly important in the sixteenth century. Anatomical texts of the early sixteenth century quite include accounts of such investigations, invoked as proof to support various claims about anatomy.[36]

Conclusion

We have seen here that two contexts, the textual tradition of anatomy and the methods and traditions of medical and surgical practice help provide the context of injection work reported by Berengario in 1521. The twin contexts are doubly important because the kind of work Berengario did with his injections has not generally been analyzed in early sixteenth-century terms and various assumptions underlying the history of anatomy require rethinking.

For example, anatomy in the renaissance is often assumed to be relatively disconnected from medical practice. The assumption has been that traditional, humoral medicine required little anatomical knowledge and physicians were therefore motivated by other concerns when anatomical grew to prominence in the sixteenth century. Recent work by historians has demonstrated the difficulty with that assumption. Berengario's injection efforts seem to be closely tied to practice, both by their methods and, in the case of the kidney, by the fact that it was a book on practice, not anatomy, which offered the dissenting view Berengario wished to explore.

Possibly as a consequence of this assumption, the history of anatomy has also wrestled with an apparent gap. Mondino's work in the fourteenth century was a clear indication of the use of human dissection to study of anatomy, but most narratives assume no "progress" in anatomical knowledge until the sixteenth century. The historian L.R. Lind once referred to the intervening years as the "fallow upland" of anatomy.[37] Berengario's injection work highlights this as a mischaracterization. Anatomy was developing in the fifteenth century, as Gardi's kidney discussion illustrates, and that development affected the work of sixteenth-century investigators like Berengario. The key to discovering that development is to look beyond books devoted exclusively to anatomy.

[36] Stolberg 2017.

[37] Lind 1975, p. 3.

The textual genre encompassing anatomy in the fifteenth century was indeed a "fallow upland", confined to brief updates to Mondino, but anatomical material was being discussed in a variety of other sources. In addition to Gardi, one can find anatomical discussions in a number of important works on medical practice from the fifteenth century, but that material has gone largely unexamined by many historians developing a narrative of renaissance anatomy. Berengario's injections show that it is worthy of more close attention.

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SOURCES AND RESOURCES OF COURT MEDICINE IN MID-SIXTEENTH ROME: ERUDITION AS AN EPISTEMOLOGICAL AND ETHICAL CLAIM

Introduction

In his medical book entitled *De arte gymnastica* (Venice, 1569),[1] the humanist physician Girolamo Mercuriale of Forlì (1530-1606) noted that the human body "as the focus of several arts and several sciences, will be reviewed by one discipline from an angle which another will ignore".[2] Indeed, the *De arte gymnastica* is a medical treatise of exceptional erudition that combines medical with broad philological, historical, and antiquarian learning. Mercuriale put together his *De arte gymnastica* during his residence in Rome (in the years 1562-1569), where he served as the personal physician of Cardinal Alessandro Farnese (1520-1589), one of the most powerful Churchmen and richest patrons at the time. In his medical treatise Mercuriale attempts to recover the Greco-Roman gymnastics in a medical context, as the "true" medical gymnastics. He promotes the medical gymnastics as an ideal method of medical treatment for contemporary use, with both preventive and curative value based on its beneficial role in the maintenance and obtainment of health.

In his endeavour to recover the Greco-Roman gymnastics, Mercuriale drew from a wide variety of textual (ancient Greek, Latin, Arabic, and contemporary) sources as well as material sources (ancient remains and objects such as coins, medals, etc.). The *Indices Auctorum* included in the book, feature 94 names in the first edition of the book, 105 in the

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[1] Mercuriale 1569. The essay rests on the translation of the original Latin text in English, featured in the Critical Edition of the *De arte gymnastica* by Concetta Pennuto: Pennuto 2008.

[2] Ivi, p. 33.

DOI 10.48255/M.9788891320186.08

second, and 122 in the fifth edition of the book. Going through the original text, we see that Mercuriale draws from a broad variety of texts: medical texts (Galen, Hippocrates, Avicenna, etc.), texts of natural philosophy (e.g. Pliny the Elder) and moral philosophy (Plutarch, Seneca, etc.), literary works (poets such as Martial, Juvenal, Horace, Homer, Virgil, Ovid, prose writers such as Cicero, Pliny the Younger), works of compilation, technical works (e.g. Vitruvius' *De architectura*), historical sources (Herodotus, Thucydides, Livy, Tacitus, Suetonius, etc.), and theological texts (the Bible and the Church Fathers, the Old and the New Testament).[3]

Mercuriale's erudition reflects the intellectual trends of the Roman *milieu* that combined, rather than divided, *scientiae*. Rome at the time was a field of many *scientiae* that flourished in courts and palaces; the papal city was populated by scholars and artists all in the service of some ecclesiastical patron. Recent scholarly research has demonstrated the parameters and idiosyncrasies that lead the papal city to emerge as a centre of scientific and medical culture in its own right during the sixteenth century.[4] The *De arte gymnastica* reflects the intellectual tastes and scholarly interests of Cardinal Alessandro Farnese and his court, which was part of the broader Roman *milieu*, in the ancient body culture and the Greco-Roman antiquity in general. It is worth noting that Cardinal Alessandro Farnese was one of the city's most outstanding collectors of antiquities and patrons of architecture and the arts, in touch with prominent active antiquarians and other scholars. Collecting antiquities was a key activity in the Cardinal's court, and it was common among the Roman social elite (ecclesiastical and lay), which was Mercuriale's audience. In fact, Mercuriale himself was a member of the Roman "Accademia degli Sdegnati", which focused on antiquarian studies. Hence, Mercuriale's endeavour to recover aspects of the Greco-Roman antiquity and the ancient body culture was benefited by his contact with other humanist scholars in the Farnese court and his acquaintances in the broader city, as well as the Cardinal's collections of books and antiquities, and the city's libraries and academies.

Over the past decades, scholars have fruitfully addressed Mercuriale's erudition and the integration of disciplines of knowledge in his work.[5]

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[3] Ivi, pp. 879-887.

[4] Romano 2008.

[5] Siraisi 2007; Pomata & Siraisi 2005; Pennuto 2008.

Nansy Siraisi has explored the *De arte gymnastica*, indicating it as an important "historical contribution" and as Mercuriale's most "antiquarian" work that reflected the intellectual trends of the Roman courts.[6] In the present essay, I revise Mercuriale's practices of erudition particularly as manifested in his suggestion regarding the outbreak and proliferation of "new" diseases. The issue of "new" diseases was one of the most controversial scientific and medical issues at the time and by bringing forward Mercuriale's discourse on the "new" diseases, I aim to highlight erudition not only a scientific tool and a way of knowing, but as well as an intellectual stance on issues regarding medical knowledge and aspects of medical practice. The present essay suggests that erudition in Mercuriale's medical discourse, sustains a source and resource of knowing and it functions also as a vehicle of criticism against aspects of the medical profession and practice at the time.

In the following part of the essay, I provide a brief account of the controversial issue of the French Disease and the "new" diseases, so as to highlight the key concerns that were raised regarding medical theory and practice. Next, I revise recent historiography on Mercuriale's suggestion on the outbreak of "new" diseases, to demonstrate the historical contexts in which it has been viewed so far. In the third part of the essay, I go through the original text of the *De arte gymnastica* and I offer a close reading of Mercuriale's suggestion of the outbreaks of "new" diseases throughout history. In the following, I try to bring forward Mercuriale's uses of erudition in the context of his claims and his response to the problems raised by this controversial issue. The conclusion sums up the key points of the essay and offers some final thoughts.

The issue of the French Disease and Mercuriale's "new" diseases in recent historiography

After the outbreak of the so-called "French Disease" (*morbus gallicus*, or *mal di Naples*, or *gallica lues*)[7] in late fifteenth century, the issue of "new" diseases quickly escalated into one of the most crucial scientific and medical problems of the era. One of the axioms of early modern

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[6] Siraisi 2007.

[7] Crosby 1969, p. 219

University medicine was that all diseases were described by the ancient medical authorities and could be found in the authoritative medical texts. Hence, there could be no "new" diseases. However, the apparent novelty of the French Disease, its intractability, the way it spread through contagion, and the rate at which it spread, for it reached epidemic proportions particularly in the first decades of its outbreak, raised questions that challenged the status of the prevailing Galenic medical theory on disease and its treatment.

The "rational and learned" (the University-trained)[8] physician was trained to think and practice within the Galenic-Aristotelian scientific and conceptual framework, which allowed him to diagnose and treat a disease according to the principles of the humoural-complexional medical theory. His professional and social status rested on the premise that his medical *apparatus* allowed him to identify and cope with all diseases. However, outbreaks of hitherto unknown diseases raised a series of issues that challenged the contemporary perceptions and understandings of "disease" (*morbus*), causing debates in the circles of learned physicians: Are diseases infinite in number? Can they arise as composites? Are diseases local to regions? Do the Galenic categories of disease account for all diseases or there can be "new species"?[9] The plethora of books of *practica* that discussed these issues, made pathology one of the most debated parts of medicine during the sixteenth century.[10]

Although the French Disease had features that differed from the diseases recorded in the ancient medical texts, at first there was a strong reluctance on behalf of the learned physicians to admit that it was indeed "new". Accepting its novelty could seriously undermine the Galenic medical *apparatus* and consequently the physician's status: a disease that was "new" meant that it could not be found in the extant medical *apparatus*, which signalled the physicians' failure to apply the treatment that the Galenic theory invited.[11] The puzzlement of the learned physicians regarding the French Disease gave room for the "empirics"[12] and itinerant healers –competitors of the learned physicians– to win over

[8] French 2003, p. 2

[9] Ibidem; Siraisi 2002.

[10] Maclean 2002, p. 259.

[11] Arrizabalaga et al. 1997, p. 263.

[12] Ivi, p. 253.

clientele by selling their "specifics",[13] which, as they claimed, could provide an efficient cure. The University-trained physicians criticized these healers, claiming that their cures were based solely on experience, rather than authoritative medical knowledge and reasoning, which made their remedies potentially harmful for the patients. Under these circumstances, the "rational and learned" doctor in his effort to address and cope with the issue of the French Disease would often stretch the extant medical theory to squeeze in the apparently "new" disease in terms of causes, symptoms, nature, and treatment, so as to understand it and treat it, defending in this way his professional status and learning.[14]

However, towards the mid-sixteenth century, the perception of the French Disease as a "new" disease was changing.[15] The cumulative experience of the French Disease made the learned physicians more willing to accept that it did not fit the Galenic model of humoural-complexional disease and the Galenic genus-species relation. Physicians started to perceive the French Disease as an "entity" in itself with a specific external cause, a "seed" or a poison-like virus that made the disease contagious in a material way. This ontological perception added a new element in the traditional Aristotelian causal system, and it implied that the disease was a sort of a natural species that had a vital cycle of birth, maturity, decline, and death.[16] The French disease was thought to have had a vigorous youth and was now growing old; it began to have a history.[17]

Mercuriale was one of the University-trained physicians that accepted the opinion that "new" diseases existed. In his *De arte gymnastica* he suggests the outbreak and proliferation of "new" diseases and he promotes the medical gymnastics as an ideal method of medical treatment, with both preventive and curative value, for the "new" as well as the "future", as he notes, diseases.[18] Scholarly research has brought forward Mercuriale's suggestion and particularly his uses of *historia*, which sustains a characteristic sample of his erudition, in reciting the outbreaks of

[13] This term refers to medicines that corresponded to the "ontological" view of disease, hence aiming at the disease rather than the patient, which differed to the Galenic "humoural-complexional" view of the disease.

[14] Arrizabalaga et al. 1997, p. 265.

[15] Ivi, p. 12.

[16] Ibidem.

[17] Ivi, p. 282.

[18] Pennuto 2008, p. 23.

"new" diseases throughout history. In her seminal work, Nancy Siraisi has marked that Mercuriale took the controversial position that "new" diseases had risen throughout history, supporting the assertion of the outbreak of "remarkable and hitherto unknown illnesses", as she notes, extending the suggestion to the outbreak of the French Disease.[19] Addressing Mercuriale's suggestion in the context of late Renaissance erudition, Siraisi suggests that the advent of "new" diseases provided new *stimuli* for historical reflection and inquiry within a medical context. These developments, Siraisi notes, probably contributed also to strengthen the connections between the professional interests of medically trained individuals and broader questions about the past, connections that emerged even more clearly with the participation of physicians in sixteenth-century antiquarian studies.[20]

Mercuriale's suggestion on the outbreak of "new" diseases, has also been addressed in the rich commentary of Concetta Pennuto's Critical Edition of the *De arte gymnastica*, provided by Jean-Michel Agasse.[21] In his commentary, Agasse addresses Mercuriale's suggestion in the context of historical conceptualizations of pathological events. He considers that Mercuriale's discussion of "new" diseases refers to diseases that had not previously existed.[22] Agasse follows Mirko Grmek's analysis, according to which, a disease might be dubbed "new" either because doctors had not previously identified it or because it did not previously exist. Following Grmek, Agasse notes that even in the latter case we must ask whether the disease was "new" only in a certain part of the world or in the whole world, whether it was "new" in relation to the immediate past or in relation to the entire history of humanity.[23]

The present essay has certainly benefited by previous scholarly research. However, the historical analysis offered so far has not taken into consideration Mercuriale's claims and arguments regarding contemporary questions on medical knowledge and practice, that stemmed from the outbreak of the French Disease. [24] As I will try to demonstrate in the following, Mercuriale's erudition in the context of the issues raised by the "new" diseases, sustains a scientific tool as well as an epistemological argument that puts authoritative medical theory and sources under scrutiny, legitimizes the authoritative use of non-medical sources in medicine, and criticizes aspects of contemporary medical practice.

[19] Siraisi 2003, p. 238.

[20] Siraisi 2007, p. 35.

[21] Pennuto 2008.

[22] Agasse 2008, p. 1050.

[23] Grmek 1991, p. 195.

[24] Kavvadia 2015.

Uses of erudition in claims and arguments on medical theory and practice

In Book I, Chapter I, *De principiis medicinae* ("The origins of medicine") of his *De arte gymnastica*, Mercuriale marks that there is a "very large number of diseases that the ancients did not know and for which no treatment had been devised".[25] However, the ancient forebears do not deserve less praise, he notes, because this was not the result of indolence or lack of skill; rather, it was the result of "the endless seductive inducements of gluttony, and insatiable lust, voracious greed, from which as Seneca and after him, Plutarch wisely argued, new species of diseases [novae morborum species] were, and still are being generated every day".[26] Right after, Mercuriale gives a historical account of the outbreaks of "new" diseases throughout time, ending with the outbreak of the French Disease, to which he refers as *gallica lues* ("French plague").

Drawing from Seneca's *Epistulae Morales*, Mercuriale reports the case of "podagra" (gout).[27] He notes that this was a known disease, which was already named and classified in the ancient authoritative sources; six Hippocratic aphorisms had addressed gout and, among other things, it was reported that women did not get gout, neither did youths until they engaged in coitus.[28] However, the changing nature of the disease, as it has started to afflict not only men but also women and children, implies the disease as "new". Next, drawing from the Roman physician Scribonius Largus (c. 1-c. 50 AD), Celsus (c. 25 BC – c. 50 AD), and Aetius (1st half of the 6th century AD) a Byzantine physician and medical writer, Mercuriale reports the case of the diseases known as "hydrophobia" and

[25] Pennuto 2008, p. 15.

[26] Ibidem.

[27] Ibidem.

[28] Porter 1994.

"elephantiasis".[29] These diseases were known, named, and classified in the ancient authoritative sources. However, Mercuriale, based on the time of their outbreak in the Italian ground, refers to them as "new"; it is considered that they first occurred in the Italian ground after the time of Aristotle and during the time of Pompey (106 BC- 48 BC) and Asclepiades (c. 70 BC) respectively, according to Mercuriale's sources.

Then, drawing from Celsus' *De medicina*, Mercuriale reports the case of a *genus mali* (i.e., a kind of harm, calamity, disaster, evil), providing a clinical description of the disease. The use of the term "genus mali" is catalytic in framing the disease as "new": it indicates the genus-species relationship in contemporary medical terms, which implied a medical condition that did not fit the Galenic model of disease. In these terms, the disease was "new". At the same time, Mercuriale marks the failure of the ancient authorities to identify the nature of this disease and prescribe a remedy for it. Next, drawing from Pliny's *Naturalis Historia,* Mercuriale describes three cases ("mentagra", stomachic pain, and leg paralysis) which are denoted as "new" based on the time of their outbreak in the Italian ground, as well as by the fact that they were "foreign" to the Italian land. The notion of foreignness is repeatedly found in early modern discourses on the French Disease. It implied "novelty" as it was considered that the disease came from the "outside" and it was the "other" that was to blame: for the Italians it was the French (see the term "morbus gallicus"), for the French it was the Italians (see the term "mal de Naples"), for the Dutch it was the Spanish (the Dutch called it the "Spanish Disease"), and so on.[30] Following, drawing from Plutarch's *Symposiacs,* Galen's *De locis affectis*, and Agatharchides (a Greek historian and geographer of the 2nd century BC), Mercuriale reports the case of what seemed to be a "new" disease. The clinical description that did not fit the Galenic model of disease, the terms used ("genus morbi" in this case) and most importantly the remark that not even Galen was aware of the disease, its nature and its causes, suggest that this was a "new" disease.

In the following, drawing again from Plutarch's *Symposiacs*, Mercuriale reports another two cases providing only the description of what seemed to be their symptoms. The nature of these diseases, as their symptoms appeared unsettling in terms of the Galenic model of disease,

[29] Pennuto 2008, p. 15.

[30] Crosby 1969, p. 219.

implies that they were "new" diseases. Then, drawing from Porphyry's *De abstinentia ab esu animalium*, Mercuriale notes that "the servant of a doctor Craterus was gripped by some new disease [novo quodam morbo] so that his flesh left his bones".[31] Here Mercuriale explicitly identifies a "new" disease using the terms "novus morbus". Mercuriale ends his account of the outbreaks of "new" diseases with the French Disease as the latest "new" disease to occur, referring to it as "gallica lues" ("French plague"). Here, both terms "gallica" and "lues" denote the disease as "new". The term "gallica" denotes the foreign (French) origin of the disease and it also implies the time and the place of the outbreak of the disease (i.e., the invasion of the army of King Charles VIII of France in the kingdom of Naples around 1494). The term "lues" (plague) was used at the time to denote a notion of disease that was different to the Galenic complexional notion.[32] As Ian McLean notes, "the unvarying clinical pattern of plague and certain fevers, and their regional character, raised the possibility that they were to be explained as entities, and not dispositions of the body".[33]

Regarding Mercuriale's practices and uses of erudition, a first important point to make is his use of *historia* in the shaping and framing of "new" diseases. As it was demonstrated, in order to shape and frame the "novelty" of a disease, Mercuriale uses arguments of historical nature. He locates the time and the place of the outbreak of a disease, giving it a beginning that can be traced in the human past; since its outbreak has a time and a place, the disease has not always existed, thus it is "new". In this way, Mercuriale attributes historicity to the outbreak of a disease, which becomes a historical event. Furthermore, as it was demonstrated, Mercuriale records a series of reports of individual cases. In this, he attributes authoritative value to *historia* as the descriptive knowledge and report of particulars through direct and indirect observation, and he manages to acquire a significant scientific tool that allows him to offer the empirical report of an individual case (*casus*) and combine ways of reading with ways of observing. In Mercuriale's medical discourse the much-debated empiricism is thus legitimized through the use of textual sources and emerges as a legitimate scientific practice.[34]

[31] Pennuto 2008, p. 17.

[32] Arrizabalaga et al. 1997, p. 238.

[33] Maclean 2002, p. 268.

[34] Pomata & Siraisi 2005, pp. 2-31.

Certainly, as we can see in Mercuriale's text as well, in the medical writings of the time references to experience (*experientia*, *experimentum*) often referred to claims found in earlier texts as well as to personal observation; even so, prominence was still given to the authoritative textual sources. Nevertheless, sixteenth century medical authors appear to have become progressively more attentive to the description of specific cases of injury or illness presented as historical and medical events. Such use of *historia* is indicative of the "learned" empiricism that characterized European learning before the strengthening of the distinction between humanities and the natural sciences.[35] In addition, attributing value to reports of individual cases is indicative of the beginning of the physicians' efforts to deal with an individual disease (providing the description of a case, its symptoms, its outcome, etc.), rather than an individual patient as was the case with the prevailing Galenic humoral medicine.[36] This shift suggests the acceptance of "new" diseases; diseases that did not fit the Galenic theory.

Nonetheless, Mercuriale's erudition functions also as his source and resource in arguing on issues raised in the medical circles at the time. As we previously saw, Mercuriale uses non-medical sources in authoritative ways in order to provide textual proof and claim that, indeed, there were "new" diseases. In this way, he demonstrates that there are deficiencies in authoritative medical sources and medical theory, and that non-medical sources can actually favour medical inquiry and can be used to enrich extant medical knowledge. Mercuriale's erudition serves in arguing over two -related- crucial issues that stemmed from the outbreak of the French Disease: i) questions regarding the value of the preventive Galenic medicine and, ii) aspects of the use of remedies in the treatment of the French Disease. It is important to take into consideration that after the outbreak of the French Disease, the preventive part of the Galenic humoural treatment was attacked as inefficient as it could not treat the disease, while controversy was raised between the various groups of medical practitioners (University-trained physicians, lay medical practitioners, itinerant healers, etc.) regarding the making, administration and efficacy of remedies that were sold as the most effective cure of the French Disease, also promising to rule out the potential and fearful relapse of the disease.

[35] Ivi, pp. 7-8.

[36] Temkin 1981, p. 258.

More in particular, the controversies between different groups of medical practitioners regarding the use of remedies were growing as the number of remedies was increasing, while the use of chemical medicines was becoming more popular in the second half of the sixteenth century.[37] The traditional learned pharmacopoeias were enriched with exotic remedies that were imported in the European ground from the New World and the East through the voyages of discovery and commerce, while northern and central European medicinal plants were assimilated and included into the learned herbals and books of simples that drew from the ancient authorities (such as Dioscorides). At the same time, the rise of chemical medicine and the use of the so-called "specifics" and "compound" drugs constituted a battleground between the various groups of medical practitioners regarding their making, administration and efficacy in the treatment of the French Disease and other ("new" or not) diseases. Indeed, notwithstanding the boundaries between the University-trained physicians and the rest of the medical practitioners, the making and administrating of remedies were shared between the learned physicians and the rest of the various groups of healers.

Mercuriale tackles both these issues. In his suggestion regarding the rise of "new" diseases, by drawing as well from non-medical texts, he implies the lack of authoritative medical knowledge on the nature and symptoms of the disease and, subsequently, the lack of proper treatment. To make up for this lack, Mercuriale draws from his erudite background: in his *De arte gymnastica* erudition functions as the source and resource to gain knowledge about diseases and their treatment, rather than resort to the use of medicines and the abolition of preventive Galenic medicine (and the ancient authoritative knowledge altogether) as inefficient. By drawing from numerous various sources (medical and non-medical, textual as well as material) throughout his *De arte gymnastica*, Mercuriale defends the value of preventive Galenic medicine, promoting the preventive and curative value of his medical gymnastics, and criticizing the use of remedies in the treatment of diseases as the result of lack of relevant, appropriate medical authoritative knowledge.

More in particular, in Book I, Chapter I, *De principiis medicinae* ("The origins of medicine") Mercuriale acknowledges that, although the curative part of medicine was the first to be invented, the preventive part

[37] Wear 2000; Palmer 1985; Gentilcore 2006; Park & Daston 2006.

of medicine is superior -even if it was added later- and he also criticizes the use of remedies: "[…] seeing that the curative, which had been invented first […], the preservative, although, indeed, added later, not only continued the name but acquired such great authority that some considered that it alone should be called true medicine, and that the other [the curative] was uncertain, false and a mere imposture on the part of those who aimed to deceive […] firstly it makes use of empty speculations and unsound arguments in gaining knowledge of diseases, secondly almost all its practitioners apply adventitious remedies and unknown drugs as much as they can, and finally they frequently make errors in both diagnosis and treatment".[38]

In addition, in Book I, Chapter II, *De conservativae partibus et quid tractandum* ("The parts of conservative medicine and what we intend to discuss") Mercuriale says "I predict that all those concerned with health will embrace it all the more strongly because the part that we are about to present [the conservative/preventive] appears to be as superior to the curative part [of medicine] as drugs themselves are inferior to exercise".[39] With regard to the use of drugs in particular, Mercuriale defends the value of preventive medicine and he argues that exercises "are superior to slimming foods and drugs in as much as it is preferable to drive out what is superfluous without any inconvenience to the body, either through the melting of flesh or through the thinning of the solid parts for there are inconveniences associated with hot and slimming drugs",[40] whereas, Mercuriale continues, exercise does not have any consequences of this sort. It is crucial to point out that remedies with such inconvenient effects (e.g. remedies based on mercury) were used in the treatment of the French Disease. In the following chapters of the treatise Mercuriale prescribes specific medical exercises for the treatment of diseases instead of using such drugs and purging practices.[41]

It is important to consider Mercuriale's remarks on drugs in relation to contemporary claims that foreign remedies imported from the New World (and other areas) could provide an efficient cure for the French

[38] Pennuto 2008, p. 19.
[39] Ivi, p. 23.
[40] Ibidem.
[41] Kavvadia 2015.

Disease, which was a claim in line with the consideration that the disease might have been imported from the New World. Questions were raised regarding the way these remedies worked, their efficacy, and whether they were better than the local medicaments. A conviction that learned physicians put forward, criticizing the apothecaries who sold them and the medical practitioners who prescribed them and sold them too, was that foreign drugs were often "counterfeited", "adulterated", "substituted", or "rotten", expressing also the fear that such drugs would not work and could actually harm for the patient.[42]

In similar ways, the use of compound remedies represented another weak point in learned medicine. Compound remedies were made from plants but also from mineral and animal substances; theriac and mithridatium were the most renowned in elite medical practice in the 1550s and 1560s, and theriac in particular was reputed to cure the plague, the French Disease, and other diseases (e.g. epilepsy, apoplexy, asthma, catarrh, etc.).[43] The learned physician would protest that only he, unlike the empiric, had the required knowledge, learning, and rationality to choose the ingredients that made up his compounds and guarantee their safety.[44] Accordingly, one of the most notable battles regarding remedies was the one between the Galenists who advocated the use of herbal remedies and the Paracelsians who advocated the chemical medicines.[45] The Galenist physicians linked chemical remedies (e.g. *aurum potabile* or drinkable gold and the remedies based on mercury) with deceit, danger, and mere empiricism. At the same time, Paracelsianism, often being identified with all the above, was accused as "unorthodox" and "heretic" by both medical and religious authorities.[46] In the light of these developments, Mercuriale's claim that the use of adventitious and potentially harmful remedies is a result of lack of relevant, appropriate, authoritative medical knowledge on a disease and its treatment, as indicated in his discourse, is crucial; what is fundamentally at stake here is the status and the efficacy of the ancient authoritative knowledge versus empiricism as manifested in the rise of chemical medicine.

[42] Wear 2000, p. 91.
[43] Findlen 1994, pp. 241-248.
[44] Wear 2000, pp. 93-95.
[45] Webster 1975; Moran 1991; Pagel 1958.
[46] Wear 2000, p. 64.

Finally, a part of the *De arte gymnastica* very distinct as far as Mercuriale's erudition is concerned, is the preface-dedication letter of the book, which is addressed to his patron Cardinal Alessandro Farnese. This part of the book has not been addressed in scholarly research so far, and the present essay considers it to be particularly enlightening regarding the broader scope of Mercuriale's erudition. In the dedication letter to his patron, Mercuriale claims that reading beyond the purely medical texts allowed him to discover that there were texts on other subjects that could contribute to his discipline (the medical discipline) and he criticizes the medical practitioners who seek glory and money, and focus on the salary (private or public from the city), rather than studying. In this way, Mercuriale argues, these practitioners do not make good physicians and they make mistakes in their prescriptions. He notes that it is important to distinguish the physicians who cure patients only for money and glory, from those who dedicate time to studying medicine and whose priority is to treat their patients and not to steal them.[47] The essay suggests that here, erudition is put forward as a broader intellectual stance with a strong moral and ethical component, and it functions as a vehicle of criticism against aspects of the medical profession and practice at the time. As Gianna Pomata and Nancy Siraisi have suggested, it was court (and town) physicians that felt more strongly the pressure to harness knowledge to the imperatives of success in practice.[48]

Conclusion

In an era of medical pluralism and in a city such as Rome, characterized by a strong competition for patronage that offered opportunities for fame, glory and profit, university-trained physicians, empirics and other medical practitioners -whether or not they agreed on the "novelty" of the French Disease-, offered various treatments trying to respond to the patients' search for an effective cure, which, as a notion, was often defined by cultural perceptions. In such an environment, we come across various groups of medical practitioners with diverse intellectual backgrounds. Undoubtedly, the intractability of the French Disease and its

[47] Pennuto 2008, p. 782.
[48] Pomata & Siraisi 2005, p. 30.

chronic nature drew attention to the logistics of the fight against it, the resources and the strategies of those teaching about it, in the attempt to prevent it and treat it.[49] It forced physicians to abandon their strict dependence on classical and medieval texts and interact with each other and with their patients and patrons to an unprecedented extent.[50] In these terms, each physician's perception of "new" disease, the French Disease as a "new" disease and the appropriate medical treatment, reflected his scholarly background, his medical rationale and understanding, his intellectual sources and resources. Overall, it reflected the physician's medical epistemology that informed the various therapeutic concepts and revealed the diverse cultural attitudes towards "health", "disease", and "treatment".

Mercuriale, a humanist court-physician, exhibited in his *De arte gymnastica* an impressive and wide-ranging erudition, as he drew from various disciplines of knowledge, combining textual and material sources. Mercuriale's erudition corresponded to the scholarly interests of his patron Cardinal Alessandro Farnese and his court, as well as the intellectual trends of the broader Roman *milieu*. It functioned in multiple ways: i) as a source of information in Mercuriale's broader endeavour to recover the Greco-Roman gymnastics, ii) as a scientific tool in the shaping and framing of the "new" diseases, iii) as a source of proof and evidence supporting his claims on contemporary medical issues and, iv) as an intellectual stance with a strong moral and ethical component towards aspects of the medical profession and practice at his time. Erudition in Mercuriale's *De arte gymnastica* demonstrates how competition with other medical practitioners and developments in the medical profession forced a court physician to emphasize his own scholarship and professional ethos as evidence of his superiority. It sustains an example of medical epistemology legitimised mainly on the grounds of professional practice and leavened with a set of ethics, molded in the mid-sixteenth century Roman *milieu*, that throws light to aspects of early modern scientific and medical culture.

[49] Arrizabalaga et al. 1997, p. 379.
[50] Sudhoff 1925, p. xi.

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Alessandra Celati[*]

THE EXPERIENCE OF THE PHYSICIAN GIROLAMO DONZELLINI IN THE 1575 VENETIAN PLAGUE: BETWEEN *SCIENTIA* AND HETERODOXY

Introduction

In this paper I am going to deal with early modern medicine as a "*Scientia*" against the background of the reception and repression of the Protestant Reformation in Italy. In particular, I will examine the 1575 Venetian plague, by taking into account the personal and scientific experience of the heterodox physician working in the Republic, Girolamo Donzellini, a very well-known medical doctor and humanist in what he himself defined the sixteenth-century *Respublica Medicorum.*[1] During the pestilence, he was serving an Inquisition life sentence in prison, and it was precisely because of the medical activity he provided in this tragic situation that he was able to re-gain freedom. As a heterodox doctor, a prisoner and the author of a treatise on plague, he provides a good case-study to frame the rise of medicine as a *Scientia* against a very tangible context: one made of cells, corpses, and pages secretly written under the first lights of the day.

In this paper, thanks to the rare evidence provided by the minutes of Donzellini's fourth trial in 1575/1576, I will describe what a prisoner doctor's daily life was like in times of plague and I will analyse the medical treatise that he wrote during his detention: the *Discorso Nobilissimo e Dottissimo Preservativo et Curativo della Peste.*[2] By taking into account

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[1] Letter by Donzellini to Theodor Zwinger, Universitätsbibliothek, Abteilung Frey-Gryn, GII 37.

[2] Archivio di Stato di Venezia (here after ASV), Sant'Uffizio, *Processi*, *Contro Girolamo Donzellini*, Busta (here after BU.) 39: see the *Capitoli della peste* (in the 1574-1575 trial). These "plague chapters" are reported in English and in the original version at the bottom of this essay; Donzellini 1577.

DOI 10.48255/M.9788891320186.09

both Donzellini's life and the book he wrote during the plague, I hope I will be able to provide fresh insights about the intersection among medical, religious and social aspects in the development of sixteenth-century *Scientia*.

Medicine, heterodoxy and the life of Girolamo Donzellini

As historiography has demonstrated, in the Renaissance period medicine was going through many changes, resulting from the humanistic approach taken up by physicians. In this period, medicine re-discovered the value of *conjecture* and its ancient nature of *practica rationale*: an epistemological shift, which invested the exploration of pathology (including epidemics), diagnosis and therapy.[3] This innovation was the result of multiple factors. First of all, the revival of the classical concept of *ars*, intended as a valid form of knowledge able to mediate between *theory* and *experience*. Such a revival derived from the reading of the original versions of ancient medical texts restored by physicians themselves, and in turn it stimulated the *reading* of the book of nature. At the same time, the gradual legitimacy of the concept of medicine as a pragmatic discipline (dealing with inherently uncertain and unstable material like individual human body and human illness) did combine with the challenges posed by the spread of new diseases and by that of old ones, which yet, bore unprecedent characteristics.[4] Finally, as physicians stressed the Galenic idea that "the best physician is a philosopher", many of them claimed unprecedented and wider spaces of freedom for this kind of rational inquiry. This complex and tortuous process legitimated an experiential approach towards the body and towards health/illness, while still distinguishing learned medicine from the unreliable methods of the quacks. Hence, a gradual move to an independent search for new theories and solutions slowly took place and new medical trends spread out in Europe, allowing physicians to acquire new lenses in the study of nature. The approaches inaugurated by Jean Fernel or Girolamo Fracastoro, and even by Paracelsus (although the latter rejected the reliance on

[3] This epistemological shift, and in particular the concept of medicine as an *ars* and as *conjecture* is the object of numerous studies, among which see in particular: Maclean 2002; Ferretto 2011; Mammola 2012; Ferretto 2012.

[4] Arrizabalaga et al. 1997.

the ancients) opened up new practical and theoretical possibilities to the adoption of experience. Donzellini incorporated these new trends in his personal scientific research and, as I will show in the second part of this paper, elaborated his own way to look at illness (i.e.: pestilences).

The changes through which early modern medicine went in the Sixteenth Century, in the attempt to reshape its epistemological and methodological ground, can be related to the contemporary experimental approach which occurred in theology.[5] In times of intellectual crisis, the turmoil which was occurring within one field could affect the other, and in fact it did. The fluid combination of physical and metaphysical approaches to reality that informed the minds of sixteenth-century men of culture, and specifically the strong connection between the body and the soul and between medicine and religion, made this intersection possible.[6] Many physicians grew non-conformist religious ideas, they spread them in the cities and villages in which they worked, and they often run up against Inquisition repression. Girolamo Donzellini was one of them.[7]

Before I can go deeper into the topic, I need to shortly sum up Donzellini's biography. And in order to do so we shall go back to another pestilence, the one that in 1513, during the Italian Wars, hit Orzi Nuovi, a little town near Brescia in the Venetian Republic. This is where our story starts. During that eight months epidemics, about 3.500 inhabitants out of 3.900 died. The sources describe this pestilence in apocalyptic terms: while stranger armies devastated the town and its surroundings, the morbus infuriated and even an angel was seen crossing the sky with a blooding sword in its hand.[8] Our main character, Girolamo, was given birth in this tragic scenario. His father, Buonamonte, had arrived in town from Verona in order to escape from the War of the League of Cambrai soon before: in this context he had married a Brescian woman and

[5] Historiography has long suggested this kind of link, dealing with Miguel Servet, for which see Bainton (2012), but also examining Italian heretics, for which see Cantimori 1939; Stella 1967, and also considering the topic in general, for which see Grell-Cunningham 1993; Brooke-Maclean 2005. Lately, historians have started to look at this subject systematically: Kostylo 2016; Suitner 2016; Celati 2018a; Idem 2018b; Idem 2019; Quaranta 2019.

[6] On the relationship between medieval and early modern medicine and religion the historiography is wide, see in particular Donato et al. 2013.

[7] On Donzellini see, Schutte 1992; Palmer 1993; Celati 2014; Quaranta 2014.

[8] Codagli 1592, pp. 130-131.

founded his family.[9] Against the odds, the infant Donzellini survived. It is tempting to imagine that, while breathing death and sorrow in the first months of his life, he was also acquiring a sort of resilience, which allowed him to survive the many perils he would encounter in his life (one more plague, torture, exile). The perils he was doomed to, however, had spirituals rather than physical features.

Having been exposed to the reception of Reformation ideas, the "*peste luterana*", in his domestic environment by his parents since he was a child, over the course of the century Girolamo became a central hub in the Venetian, Italian and even European network of heterodox thinkers. A fruitful "asset" in this respect, was the fact that he graduated in Padua (1541), where he cultivated relationships with students and colleagues coming from all over Europe, and in particular from Germanic lands. In Padua, he was taught by some of the main innovators of Renaissance medicine, like Gian Battista da Monte and Andreas Vesalius, and as a professional doctor, he became well respected and obtained prestigious jobs. He worked in Rome, as the personal doctor to two cardinals; in Venice, healing the English ambassador; and even in Germany, where he had to escape in 1553 in order to avoid his first Inquisition trial. During his exile he received prestigious job offers from the archduke Ferdinand and from his sister the queen of Poland and he initiated relationships with illustrious political figures including the emperor, who finally provided him with a safe conduit. During the exile, having already being influenced by the spiritual currents of the Italian Reformation when he was in Rome (i.e. Valdesianism), he made his doctrinal profile more and more nuanced. He renounced any religious dogmatism and he opened up to hermeticism both in science and in religion. This is shown by his collaboration, in Basel in 1559, with the group of radical exiles and promoters of religious tolerance gathered around the printing press house of Donzellini's dear friend Pietro Perna, within which he produced an edition of Themistius' orations introduced by a dissertation on the concept of *docta religio* (or *Prisca theologia*), and, in the years to come, by his interest in Paracelsianism.[10]

[9] Redmond 1984, p. 14-15.

[10] On Pietro Perna, see Rotondò 1974, pp. 273-391; Perini 2002. On the Basel group see: Cantimori 1939, in particular pp. 117-127; Biagioni & Felici 2012, pp. 90-94 and *passim*. On Donzellini's interest in Paracelsianism see Ferrari 1982, pp. 23-24. On *prisca theologia* see Muccillo 1996; Vasoli 2010, pp. 175-205. See also Donzellini 1559.

When he went back to Veneto in 1560, having taken up a *nicodemitic* approach to religion, he got away with a light Inquisition sentence, and after that he became a member of the College of physicians in Verona.[11] Here he developed with some of his colleagues harsh medical controversies about the nature of pestilential fevers, which resulted in a new denunciation to the Inquisition and in the detention that is the object of this paper. Over the course of his entire life, he dealt with the publication and distribution of reformed-oriented books, most of which were published and smuggled with the support of Perna. Donzellini also corresponded for almost 30 years with Protestant humanists in Germanic lands, acting as an intermediary in the importation of learned (mostly medical and philosophical) volumes, prohibited in the different "classes" of the numerous Indexes that, in the second half of the century, followed one another in Italy.[12] It was indeed the possession and the circulation of forbidden books, which he was uncapable to renounce, that finally sealed his fate. After one more trial (1578), he was caught by the Inquisition again and drowned in the Venetian lagoon in one spring night in 1587. He was 74 years old.

Facing the plague in an Inquisition prison

Having provided some more context, let us now move *in medias res*. The epidemic of plague that affected Venice in 1575 was one of the most traumatic that the city ever experienced. Over the course of two years, more than 50.000 Venetian citizens died. Since they worked in close contact with the ill, physicians were particularly exposed to the contagion and, after one year, most of the doctors in the city had either died or escaped to the countryside. Reading the documents of the Venetian College of Physicians, one can apprehend the concern that public authori-

[11] Archivio di Stato di Verona, *Atti del Collegio de' medici*, *Comune* 610, (30th July 1561-30th September. 1569); *Comune* 611, (13th December. 1569-14th April 1574). Donzellini was expelled from the College as a heretic in 1575. On the concept of nicodemism see at least the masterpieces, Rotondò 1967, pp. 991-1030; Ginzburg 1970.

[12] This activity emerges from the correspondence of Girolamo Donzellini: see the letters he sent to Theodor Zwinger in Basel, Universitätsbibliothek, Frey-Gryn Mscr I and II, G II and G2 II; and those he sent to Joachim Camerarius Jr, in Erlangen, Universitätsbibliothek, Briefsammlung Trew. This correspondence has been studied by Alessandra Quaranta: Quaranta 2014, pp. 1-34; Idem 2018, pp. 72-101; Idem 2019.

ties nourished towards the lack of physicians who practiced in the context of infected Venice. In June 1575 doctors were ordered not to leave the city, but the documents report that many disregarded this directive. Probably the fact that they were supposed to heal the population, running the highest risk, with no additional salary, had an impact on this choice. If nothing else, the rents that physicians had to pay to their landlords would be suspended for the time being, but apparently this was not enough.[13]

As I pointed out above, during the plague Donzellini was in prison. In 1575 he had been condemned to a life sentence, and the numerous pleas that both him and his desperate wife Lucrezia sent to the Inquisitors could not change his condition.[14] As a trick of fate, it was instead the burst of the plague, and the chance to show his loyalty to the Venetian civic and ecclesiastical authorities, that favoured him. Fulfilling his duties as a Venetian prisoner, citizen and doctor, and serving his penalty while taking care of ill Venetian people, he could restore his reputation and possibly re-gain his freedom. The description of the time he spent in prison during the plague is reported in some "plague chapters" that Donzellini wrote and submitted to the judges so that he could highlight his honesty and reliability.

In these chapters, Donzellini narrates that between the end of August and the beginning of September 1576, the plague spread out in the *sestiere di Castello*, the area where the Inquisition prison was, and in a few days the bacterium penetrated inside the prison itself. The wardens died, and at this point, Donzellini and his fellow prisoners were abandoned to themselves. The building was put in quarantine and everybody was denied access to it. As a result, the prisoners found themselves completely neglected. There was nobody who would bring them food or water, nobody who would take care of cleaning the place, removing garbage, excrements and corpses.[15] The only person who showed some mercy for

[13] The information that I provide in this paragraph, about the city policy towards physicians and their general behaviour during the 1575 pestilence, come from: Venice, Biblioteca Marciana, Ms Ital VII (2342=9695), *Notizie cavate dai libri dei priori*, ff. 15*v*-16*v*. For the general regulations that Venice adopted in times of plagues since 1541, see Bell 2019, pp. 177-178, who publishes the text of the Venetian "plague orders" – the ordinance which regulated the system of examinations and notifications related to the discovery of contagion.

[14] ASV, Sant'Uffizio, *Processi*, *Contro Girolamo Donzellini*, Bu. 39, f. 195*r*; 200*r*.

[15] Ivi, f. 203*r*.

the inmates was an agent of the Inquisition called Biasio, who managed to get the gates of the prison opened and allowed the prisoners to beg for food on the threshold. In his chapters, Donzellini underlines that for ten days he and his fellow prisoner, friend and comrade in faith Nascimbene Nascimbeni stayed in prison, despite the gates being open, and even convinced (and actually forced) other prisoners not to leave "for their own sake".[16] Donzellini wanted to present himself as honest and trustworthy. His final goal was to be pardoned, not to spend the rest of his life at large. In a condition of despair and great danger for his safety and life, he was able to calculate costs and benefits of his actions: he took the burden of a concrete risk of either contagion or starvation for the time being, in exchange of a potential liberation to be obtained in the future. Time proved that he was right in his calculation.

Before that, however, he had to endure a dreadful situation. The number of people who died around and inside the *cason* (the Venetian name of this Inquisition jail) rapidly increased, and Donzellini and Nascimbeni started to submit several pleas to the ecclesiastical authorities, begging to be transferred to a safe prison. However, they were denied mercy. Particularly striking for Donzellini must have been the death of Giulio Trissino, the only prisoner killed by the plague that Girolamo overtly nominates in his report. Trissino belonged to the aristocracy of Vicenza, strongly pervaded by reformed ideas. He was the archpriest of the cathedral of Vicenza when he converted to Calvinism, in the 1530s. Since then, he became active in heterodox networks, cultivating relationships with the circle of Renée de France in Ferrara and even with Zwingli.[17] It is not surprising that, in prison, Donzellini became friends with a man who was so much involved in the Italian and extra-Italian circuits of the Reformation. After Giulio's death, Donzellini and Nascimbeni felt particularly scared (had they been in close contact with him? had Donzellini tried to heal him?) and insisted to be moved to a clean place. However, the only answer they repeatedly received was "to be patient". They then turned to the municipal authorities, but the latter refused to help them as well, asserting that Inquisition prisons were beyond their jurisdiction.

[16] Ibidem. On Nascimbene Nascimbeni, see Prosperi 2000 *ad indicem.*

[17] On Giulio Trissino and the heretical circles of Vicenza see: Olivieri 1992, pp. 345-348 and *passim*.

Donzellini's firmness was rewarded on September 24th when he was relocated along with Nascimbeni, in a clean house in San Giuliano, and he was given the permission to go out in the city to heal the ill. The decision was not agreed on by every side of the Inquisition, and two months were necessary before the religious and the social-political institutions, who bored opposite interests, could come to a compromise. While the patrician lay members (whose presence within the tribunal was a unique characteristic of the Venetian Holy Office) first agreed and then actually *forced* Donzellini to practice medicine (under a 500 *scudi* bail), the patriarch of the city did not trust Donzellini and did not want to let him go out in the city.[18] The motivations for this opposition are clear: only 5 years before, in 1571, the whole community of physicians in Venice had been the object of an attack by the Inquisition (*Contra medicos*), which charged Venetian doctors with the allegation of disregarding the *Super Gregem Dominicum* (the papal bull that forced physicians to stop providing care to the patients who did not confess).[19] The ecclesiastical authorities were aware of the propagandistic potential inherent in the medical activity, and they wanted to submit the medical community, as much as any other social category, to the Counter-Reformation action.[20] If this was not enough, they certainly mistrust Donzellini in particular: during the trial which resulted in the 1575 detention, the doctor had been discovered having performed religious propaganda while practicing medicine, managing to convince two nuns to escape the nunnery of Santa Lucia in the early 1550s.

This episode shows how the distinctive ecclesiastical and political jurisdictions typical of early modern Venice, would overlap and compete in a time of sanitary and religious emergency (the *peste luterana* was not yet defeated). The municipality's civic and political interest clashed against the Inquisition's disciplinary goal and as the "plague chapters" report, several political and diplomatic actions were needed before Donzellini could start healing the infected. Finally, the aristocrat Danilo Priuli, stressing the professional value of Donzellini and the tragic situation of the city, interceded with the Patriarch, and the prisoner doctor was allowed to start practicing medicine on December 16, 1576. Donzellini concludes his chapters by stressing his own charity and benevolence towards the poor ill, whom he assisted without earning any money and actually self-sponsoring the expenses due for the medication. In April 1577, he was finally pardoned.

[18] As it is well-known the Venetian Inquisition had a peculiar institutional configuration and in Venice jurisdictional issues among the political and the religious power (and between Venice itself and Rome) were not rare. Historiography on this subject is wide, see at least: Paschini 1559; Del Col 1988, pp. 244-294; Idem 1991, pp. 189-250; Idem 2006, pp. 342-394. In this case, the Inquisitor immediately authorised Donzellini to practice medicine, the Patriarch remained long reluctant (see the "plague chapters" at the bottom of the text).

[19] ASV, Sant'Uffizio, *Processi*, *Contra Medicos*, Bu. 35.

[20] Celati 2018, pp. 72- 91.

Donzellini's prison work: healing the body, nourishing the soul

Before being pardoned, and while living in the dreadful state I described, Donzellini concentrated all of his physical and intellectual energy on writing a *Very noble and learned discourse which can heal and preserve from the plague* (*Discorso nobilissimo e dottissimo preservativo e curativo della peste*).[21]

This work meant to advise the *Provveditori alla Sanità* on how to handle the epidemic. In the text, Donzellini put forward theoretical insights along with practical suggestions. I argue that, in addition to its immediate pragmatic goal, the writing of such a treatise bore, for a man of culture like Donzellini, a subtler meaning. In times of "great mortality" and "big catastrophe", Donzellini found consolation in his medical vocation and in the use of his own "reason". Moreover, as we have already seen, Donzellini was trying to turn the plague circumstance to his advantage: in this case, he probably thought he would gain respect from the authorities by offering them such medical contribution, and, as a result, he would increase the likelihood to be pardoned. Indeed, he composed (or at least he started to) the treatise in the hardest times of his imprisonment, in the dark of his cell, without having the chance to consult any book and only relying on his knowledge and his memory. The dedication to the *Provveditori alla Sanità* is dated December 3rd, 1576, which implies that Donzellini conceived of this work in the terrible time I described above and before he could walk through the city to heal the infected.

[21] This book has received attention by Preto 1978, pp. 60-63; Cohn 2011, pp. 165-166, 274-275.

The treatise bore an ill-concealed polemic against the two Padua professors Girolamo Mercuriale and Girolamo Capodivacca.[22] When the morbus had just started to spread out, the two physicians had received by the Venetian authorities the task to verify whether it was indeed a form of plague, or not. Since Galen had asserted that a high level of contagion was a fundamental characteristic of plague, and since in the Venetian epidemic of 1575 the contagion increased over time, but was limited at the beginning, the two physicians all too soon ruled out that it was not plague. As it is well-known this was a disastrous mistake. Not only did the two professors hinder the sanitary authorities from taking the correct measures against plague, but visiting the ill without observing the necessary prophylaxis, they actually contributed to the diffusion of the morbus.[23] On the other hand, the prisoner Donzellini clearly maintained that plague should be diagnosticated whenever specific symptoms were detected, regardless how little the amount of people infected was and no matter what Galen had taught.[24]

In the most genuine humanistic approach, Donzellini's way to look at illness and at the human body did not passively reproduce the knowledge of the ancients, although his method was deeply grounded in their teachings. In the first part of the treatise, Donzellini shows to be familiar with and to put into practice a strongly *conjectural* concept of medicine. For instance, when examining the aetiology of the Venetian plague, he maintains that different plagues have different causes that depend on the different contexts in which the morbus develops. The attention towards the specificity of the Venetian environment leads him to rule out that the 1575 plague could have derived from the corruption of the air: the salt which exhales from the water prevents the air from rotting. Moreover, taking into account also historical/social aspects, he is able to determine that the current plague was not due to malnutrition: that year there had been no famine.[25]

[22] On Girolamo Mercuriale see Mercuriale 2008; Arcangeli & Nutton 2008. On Capodivacca see: Gliozzi 1975.

[23] The episode is examined in Nutton 2006, pp. 5-19; Siraisi 2007, pp. 102-105; Palmer 2008, pp. 51-65.

[24] "Even if there was only one case in the world which had that poisoned characteristic of plague, which is the essence of the plague, along with its effects and accidents, there would be no doubt that it would be plague although it did not create a popular epidemy. Yet, it is true that where the plague meets crowds, it spreads very easily". Donzellini 1577, c. 1*r*. A similar argument is advanced at c. 2*r*.

[25] Donzellini 1577, c. 6*r*-6*v*.

The cause of the plague was therefore "the contagion" triggered by the importation of infected objects from Trent, soon before.[26] In particular, in this section Donzellini shows to be well aware of the novelties brought about by medical scholars in sixteenth-century physiology. When explaining how the contagion spread out, he spoke about the "*seminario della peste o fomite*" (the plague seed or *fomite*), which men breath in and which "penetrate the heart and infect the spirits of the whole body": by doing so, Donzellini referred to Girolamo Fracastoro's theory, enunciated in 1546, although he did not quote him directly.[27] In the thought of Fracastoro, a multifaceted man of culture, who dealt with astronomy and literature along with medicine and philosophy, the theories of the ancients are harmonised with what experience shows. An approach which matched Donzellini's. A certain convergence between the two physicians was also made possible by the fact that both shared a Neoplatonist conception of nature, perceived as animated and alive. Relying on this image of nature, Fracastoro spoke about the very least of its components, what he called *seminaria*, which were involved in the organic process of spontaneous generation and self-destruction and were responsible for infective diseases. Following Fracastoro, Donzellini stated that an important agent in the spread of plague was a "filthy microscopic animated body called *seminario* or *fomite*", which moved from object to object, including human skin and propagated the morbus.[28] Then he reminded the sanitary authorities about the fact that, although at an early stage the diffusion of the bacterium was limited, all the necessary prophylactic measures needed to be taken when even one only person showed certain symptoms characteristic of plague. Otherwise, the infection would turn into an epidemic.

In some other books by Donzellini it is possible to apprehend the same interest towards sixteenth-century medical innovations. And in particular, towards those currents which conceived of illness as ontologically autonomous and which stressed the importance (and the existence) of the secret properties of substances. In the last book he wrote, the *Remedium ferendarum iniuriarium* (1587), Donzellini referred to the concept of "*tota substantia*" developed by Fernel and reflected upon the ways in

[26] Ivi, c. 6*v*.

[27] On Fracastoro see: Nutton 1990, pp. 196-234; Peruzzi, voce *Fracastoro, Girolamo*; Pastore & Peruzzi 2006; Pennuto 2008.

[28] Donzellini 1577, c. 6*v*-7*r*.

which different physical/animal bodies behave and interact, and above the mechanisms of sympathies and antipathies in nature.[29] Many years before, in one of the first texts he wrote, he lined up with a colleague, Vincenzo Calzaveglia, who claimed the efficacy of theriac in the cure of pestilential fevers (so much so that his rivals denounced him to the Inquisition in order to get rid of him, as I have anticipated above). The attention towards poisons and towards the mysterious dynamics which operated in nature is continuous in Donzellini's thought and I argue that it mirrored his inclination towards religious spiritualism. It is not possible to go into details here, but I suggest that it is not coincidence that other doctors, who inclined towards spiritualism and had been influenced by Valdesianism, such as Bartolomeo Maranta or Vincenzo Abbaticchio, zealously explored the inscrutable world of poisons, studying their powers and their properties and deepening in particular the functioning of the most enigmatic of remedies, theriac.[30] As a matter of fact, we also know that Donzellini knew and read Paracelsus sometimes in the 1570s, although his relationship with the Luther of physicians is still controversial.[31]

Going back to the *Discorso nobilisismo,* the most relevant feature of this book is the conception that medicine is a "practical discipline", an idea which goes hand in hand with a strong optimism about the possibilities of the therapeutic action. Thanks to human reason and to the value of experience, the good physician can obtain any result, including the permanent extinction of plague. This optimistic approach also explains why Donzellini wrote his treatise in Italian: he wanted to divulge his "preservative and curative system against the plague" and make it understandable also by popular social classes. If Venetian citizens were able to recognize the symptoms of the morbus, they could take the necessary precautions and limit the diffusion of the contagion. Moreover, Donzellini was aware of the fact that the poor were particularly exposed to the morbus and that they often concealed to the authorities their infected status, in order to avoid seeing the few goods they owned being burnt, and not to be taken to the Lazzaretto (which Donzellini considered the

[29] Donzellini 1586, c. 51*r*-51*v*.

[30] Minervini 2004; Ricci 2002.

[31] Celati 2014, pp. 5-37.

waiting room of death).[32] With this in mind, Donzellini seek to obtain the collaboration of the population, and he advises the sanitary authorities to employ skilled learned physicians in the hospitals; to turn on many fires in order to purify the contaminated air; to facilitate the production and sell of pricey medication (even describing how to prepare these remedies at home); and he suggests those who had the money for doing it, to escape the infected city as soon as possible.

Donzellini's pragmatic approach did not entail a refusal of the connection between medicine and religion, established since the middle ages. However, he declined this relationship in a non-Catholic way. While he thought that man was in the hands of God, who was ultimately responsible for man's health, sickness, life and death, religious practice took for him an individualistic and introspective shape. He did suggest praying to God in order to be free from the morbus, but he did not refer to any collective ritual or religious intermediate. It can be useful as a comparison, to mention the thaumaturgic measures that at the very same time Carlo Borromeo was bringing about in order to fight back the plague in Milan: processions, propitiatory masses, fasting, devotion to the saints.[33] On his hand, Girolamo, hostile toward Counter-Reformation culture, claimed that the only valid spiritual remedy was interior faith and the certainty that, praying to God with a sincere heart, the believer would be safe.

> The general cause of all pestilences is the will of God, which is the source and the cause of everything's origin. For this reason, the first therapeutic and prophylactic remedy is the pray to the great God, who sent the plague for no other reason than to punish the sins of men. But God is bent by men's repent and orations, he changes his mind and relieves men from the flagellum. In fact, the good Christian has no better means to make his wishes be granted by God than praying to him, with perseverance and strong faith, that God satisfies him.[34]

[32] Donzellini 1577, c. 4v. On this subject see Carmichael 1986, an examination of the connection between plague and the poor in mid-fifteenth-century Italian cities and the related legislations that municipal and sanitary actors established (also as a disciplinarian measure against the burden of poverty), of which the Lazzaretto was an essential part.

[33] Preto 1978, pp. 77-79.

[34] Donzellini 1577, c. 4*r*.

As I mentioned, the practice of medicine in time of plague and the publication of the treatise allowed Donzellini to be pardoned. The work was also appreciated outside the Venetian context. Donzellini's friend and correspondent Joaquim Camerarius edited a Latin version of the text. Camerarius included the work within a *Synopsis ... de peste* published in Nurnberg in 1583 and this work was included in one of the lists of books which were compiled for the preparation of the Sistine index of prohibited books, with the label "*Donzellini et al.*"[35] Considering the attention that the ecclesiastical authorities paid to Donzellini it is not surprising that they also inquired into his scientific works. This censorship can only be found in the Sistine index. In the list compiled for Clement VIII's index in 1596 the work does not appear; however, after Donzellini's execution, and probably because of that, the circulation of the work, with its reformed-oriented approach to religion, was hindered and stalled.

Conclusion

As Samuel Cohn has shown, Donzellini's work shared some characteristics with other treatises published during the 1575 pestilence such as the vernacular language, the ambition to make some practical difference in a situation of emergency, and a certain open-mindedness about how to interpret Galenic knowledge.[36] However, I think that Donzellini's case is especially meaningful and not just because in his book these characteristics are particularly striking. The fact that he came to such conclusions while writing alone in his cell, suggests that fresh trends in medicine were then circulating enough. Simultaneously, the same occurrence suggests that, while still free, a "heterodox physician" like Donzellini had not been marginalised by his colleagues for having been on trial twice (1553, 1560), and that he had had the chance to take part in the medical debate to a deep extent. So, when speaking about *heresy*, we need to avoid any reductive simplification that could lead to divide the early modern society into distinctive "religious zones": while this was probably the goal of the Inquisition, the medical professional network in

[35] Baldini & Spruit 2009, vol. I, p. 318.

[36] Cohn 2010, pp. 274, 275.

Venice admitted a grey zone in which a therapist like Donzellini could operate and flourish.

At the same time, Donzellini's religious inclination circularly impacted and nourished his medical approach. Not only is this visible with respect to the connection between his spiritual approach to Christianity and his interest in the medical theories that investigated the secret elements of substances. Donzellini also showed a pragmatic approach to medicine, and in this regard, his book can be compared to the one that, during the same plague, the heterodox exile doctor Simone Simoni wrote in Leipzig.[37] The two non-orthodox physicians shared an open-minded way to look at the medical doctrines of the ancients, they both committed to the provision of practical advice to the ill and to the institutions, they both referred to minor authors and practitioners as valuable sources to fight back the plague (Donzellini mentions the *speziale* Bellicocco in Verona, Simoni an unknown doctor who was a friend of his in Germany), they were both aware of the innovations brought about by their colleagues (apart from Fracastoro, they also refer to Falloppia), and they both focussed on the social, environmental and even psychological aspects of epidemics.

Another treatise on plagues and epidemics can be quoted in a similar vein: the one written by the heterodox physician from Ferrara Marcantonio Florio in the 1570s and published by his son, after the author was dead, in 1587. Florio had been a follower of Giorgio Siculo (the heresiarch who had funded the sect to which Nascimbene Nascimbeni, Donzellini's cellmate, belonged too) and he had been sentenced to life in prison in 1568.[38] Like Donzellini, he was pardoned years later, in 1574. It is possible that Florio wrote the book in prison like Girolamo, although the text shows no clue in this sense (the fact that book was not published when the author was alive suggests that it did not obtain much success and was hardly related to the prisoner's release). What is certain it that the book was written after 1572: when dealing with the possible causes of epidemics, Florio speaks about the years between 1570 and 1572, referring to some natural events (Ferrara's earthquake in 1570 and an infection that, in 1572, hit the animals of the area) that he says happened

[37] On which see: Nutton 2006, pp. 5-19.

[38] Prosperi 2000, p. 280.

"years ago".[39] Although we cannot know whether the book was conceived and written in prison, the attention that Florio poses to the natural and medical events that happened during his imprisonment makes this treatise comparable to Donzellini's, while his attention towards practical remedies and their recipes, to be composed by common people (which covers 90% of the book), makes it very similar to Simoni's too.

The case of Donzellini also shows that the catastrophic event of plague could turn the regular social dynamic upside down, inverting religious order and intellectual hierarchies. The prisoner Donzellini gained more respect for his medical intervention than the prestigious professors Mercuriale and Capodivacca did. And as a result of the plague, the gates of the prison were opened, and even a "heretic" serving a life sentence like Donzellini was granted pardon, which implies that plague somehow suspended the ecclesiastical law. The case of Donzellini is somewhat exceptional in this respect. In times of plague, Italian cities had long legitimated the expulsion of specific categories of people: individuals who could be physically contaminating (such as lepers, in addition to the plague-infected themselves) and persons who could be morally contaminating, like prostitutes and heretics. Against the latter, it was allowed to use all the necessary violence.[40] Donzellini's exceptionality needs to be related with his professional skills, which he made available to the infected city: one more interesting way in which medicine and heterodoxy intermingled in his experience.

But his case also illustrates how bizarre history can be. In one simple twist of fate, the same contingency which had blessed Donzellini, seemed to doom him again. As I mentioned, during his imprisonment, he had become close friends with the radical heretic from Ferrara, Nascimbene Nascimbeni. After being pardoned, Donzellini continued visiting Nascimbene in jail as his doctor, and insisted with the judges that Nascimbeni should be moved to a healthier place. The judges then decided that Donzellini would be responsible for Nascimbeni's health and gave the prisoner over to his custody. However, while confined at Donzellini's house, Nascimbeni broke out and left the city, putting his friend in trouble. As a result, Donzellini lost his freedom again and he temporarily lost the possibility to practice medicine.[41] We know how his story ended.

[39] Florio 1587, c. 5.

[40] About these laws see for instance what is reported in Previdelli 1524, 4*r*, quoted in Pastore 2006, and Pastore's examination, p. 39.

Plague chapters (English translation)[42]

Since myself Hieronimo Donzellini and [my friend] Nascimbene Nascimbeni have always been obedient and respectful, in the deep of the heart, towards you illustrious lords, God has decided to give us the chance to prove our loyalty. And although nothing is more of a challenge than the risk of losing one's own life, which is the dearest thing to anyone, we put our life in danger twice, with the specific purpose to demonstrate our devotion to this holy tribunal.

The first time was when, deprived of any human support and of all the goods which are necessary to sustain this terrible life, for many days we stayed in need of food and water.

The other was when we thought that death was coming for us at any time, since people continued to die, not only in the houses close to us, but in the very one in which we were living -- where six people died. And, despite the gates of the prison being open, we had a strong convincement in our soul, that we would rather have died remaining obedient to the Holy Office, than save our life by abandoning the prison without being authorized.

Although this thing is acknowledged already by everybody who know us, so much so that we are certain that your illustrious lords know it as well, nonetheless we thought it was worthwhile writing down some chapters (through which one could understand the history of our perennial obedience) and to present these chapters to the Holy Office, since you may either not know the details, or you may have some doubts. We beg you illustrious lords, that, considering the above mentioned obedience, along with our old age, our infirmity, and the infinite trouble and pain we have been going through, you will grant us freedom, and not because we deserve it, but because you are clement and merciful and because Jesus Christ died for all of us. We pray to our Lord for your joy and we genuflect in front of you.

[41] This episode of Donzellini's life can be examined in Nascimbeni's trial: ASV, Sant'Uffizio, *Processi, Contro Nascimbene Nascimbeni*, Bu. 30.

[42] For the English translation I have slightly adjusted punctuation where necessary.

Chapters by Doctor Girolamo Donzellini and mister Nascimbene Nascimbeni produced in order to prove with witnesses our loyalty towards the holy inquisition of Venice.

Between the end of August and the beginning of September, as ourselves (above mentioned Donzellini and Nascimbeni) saw that the plague was not only killing people in the surroundings, but it had penetrated in our *cason*, we sent letters to the father Inquisitor and to lord Foscarino, asking to be moved to a different prison. We did not get any response, other than trying to be patient, because the Inquisitor was in quarantine, for the death of many friars. And since in the *cason* the wardens died from plague, and three women who used to work in the prison moved out being infected (and soon they died at the Lazzaretto), we urged again the above mentioned lords, by sending them letters, but again we were told to be patient.

Since there was no one who could bring food, wine and water, and no one who could throw away the daily garbage, we, Donzellini and Nascimbeni, sent letters to the civic authorities of the *sestiere di Castello in San Zaccaria*, begging that someone would provide for our needs. However, the answer [from the civic authorities] was that they could not do anything, since this was not their jurisdiction.

Urged by hanger, since we continued not to receive any support by anybody, we opened the gates in order to beg for food on the threshold, being authorized by the Inquisition official Biasio.

For ten days we remained obedient and stayed in prison, in spite of the fact that the gates were open, and we could have gone wherever we wanted.

When a prisoner, Costantino da Osiago, planned and then managed to flee (and was condemned to the galera), another prisoner, Niccolò da Castelfranco, wanted to follow him, and we, Donzellini and Nascimbeni, exhorted him to remain obedient. And because he was stubborn and wanted to leave, we locked with a chain the door of the prison. He went out of mind and said that such a behaviour deserved the dagger, to which we replied that we were acting like that for the sake of him and that we needed to tie him like a crazy person, and finally we managed to persuade him, and he became calm and remained in the open prison being obedient.

In the days when the prison was open, not only was our life in danger because the house was infected, but also because the people in the surroundings were dead or they were in quarantine, in a bigger quantity than those who were alive, [and I mean] the people who sell food in the neighbourhood: shepherds, fruit sellers and others were died or in quarantine.

When the prison was open, we immediately sent letters to the very reverend Inquisitor and to the excellent Foscarini, to inform them about the circumstances which had forced us to open the doors and to tell them that we did not want to leave without permission, and again we begged to be moved to a clean place, but we did not obtain anything because of the current ruin produced by the plague.

When our fellow prisoner Iulio Trissino died, hearing death approaching we begged again Biasio that he interceded with the judges and made them aware of the serious danger in which we were all living, since we preferred dying obedient, rather than leaving without permission, and we were certain that our lords would have been merciful.

The father Inquisitor, having heard Biasio's words and having been alarmed by lord Foscarini, decided he did not want to let us die and, appreciating our obedience, asked Biasio to tell us that we could go to a clean house and that, after 22 days, me, Doctor Donzellini, could treat the infected.

In order to allow me to practice medicine, the father Inquisitor wanted from me, Doctor Donzellini, a bail of 500 *scudi*, and he recorded this act on September 24, 1576, thanks to a notary who worked in S. Basso. After our quarantine, the first time we went out we went to visit the Inquisitor, who confirmed the order.

The doctor of the neighbourhood of San Giuliano in which we had been moved visited us, and myself, Donzellini, I was prayed to visit the poor ill and, considering the great danger that the whole city would have been in if I refused, I decided to accept.

Since I was ordered by the Patriarch of Venice that I did not leave the house and did not practice medicine, I was obedient. However, the lord patricians, and especially lord Bragadino, reassured me that I needed to serve my fellow citizens providing them with medical care (since most of the physicians had already died, and there was a great necessity of doctors): they had established in Santo Stephano that the Patriarch had to concede me the licence to practice medicine.

As I did not want to disobey the Patriarch, I was subjected by the civic authorities to a potential 500 *scudi* fine, in case I did not obey and started treating the infected in the whole *sestiere* of Saint Mark.

When I received this order, I refused it, unless the political authorities convinced the Patriarch to accept the order as well: I did not want to be disobedient towards your very reverend lord.

Mr Bolani again threatened me with the above mentioned fine, if I did not obey and promised he went to the Patriarch in order to obtain a license which allowed me to work.

Since he could not go in person, being very busy, he sent a letter to the Patriarch, asking that, for the sake of the city, I could practice medicine.

The letter, along with another similar one sent from lord Danilo Priuli (who also wrote to the Patriarch, having heard of the value of the physician [Donzellini] and knowing of the great necessity of medical doctors that the city had), was presented in front of the Patriarch on December 12, 1576.

Myself, Doctor Donzellini, have always proved to be good towards the poor, treating them with generosity and compassion, without receiving any compensation, and actually aiding them with my medical remedies for free, and sometimes even spending my own money.

Since I was ordered to present myself to the new prisons, I always declared that I was happy to obey, but I prayed the Holy Tribunal to discharge me from the penal warrant.

Original text from Donzellini's Trial (*Capitoli della peste*)

Sicome la volontà di mi Hieronimo Donzellini et Nascimbene Nascimbeni sempre è stata verso voi signori illustrissimi humilissima et ubidientissima nell'intrenseco del cuore, così è piaciuto alla divina maestà mandarci occasione per la qual potessimo farne esterior testimonio et darne pienissima certezza. Et poiché non è maggior cimento di quello della vita, cosa sopra tutte l'altre carissima, noi in due modi l'habbiamo esposta a manifistissimo pericolo, solo perché questo sacro tribunale con erudictisima dimostratione conoscesse l'intrinseca devotione e ubidienza nostra.

Il primo fu quando privi di servitù et delle cose necessarie alla sostintazione di questa infelice vita, per molti giorni fossimo in gran bisogno de necessari alimenti.

L'altro quando non solo per le case ci eran vicine ma per la stessa dove noi eravamo, essendovi morte sei persone, ogni ora credevamo la morte vicina per la peste. Et benché le porte ci erano aperte, sempre però ne steti nell'animo un risoluto proponimento di voler più tosto morir in ubedienza al Santo Officio che senza licenza partendo salvar la vita.

Questa cosa benchè sia notoria et a tutti che ci cognoscono apertissima tanche non dubitiamo che ancho a voi signori illustrissimi sia notissima, nondimeno perché può esser che non a tutti sia chiara, et che molti particolari non siano venuti alle orecchie loro, ci è parso notar alcuni capitoli, nei quali si comprende la historia di questa nostra perpetua ubidienza e presentargli a questo Santo Officio supplicando che ci sia fatto gratia di essere accettati se non ad altro fine almeno a ciò ne gli atti questo sacro tribunale sia ritratto d'esemplar ubedienza, a vostri posteri proposto ad imitatione. Supplichiamo anchora voi signori illustrissimi che considerata la già detta ubbidienza la grave età, le infirmità, gli infiniti danni, pene et tormenti già tanto tempo da noi per ubidienza tolerati, non già per merito o dignità di nostra ubidienza, ma per gratia, benignità, clemenza et misericordia di questo sacrosanto officio et per i meriti del nostro salvator Hiesu Christo ci sia concessa quella libertà che voi signori illustrissimi parerà di concederne: alli quali pregando dal nostro signore Dio filicità humilmente et genuflexi ci raccomandiamo.

Capitoli prodotti dall'eccellentissimo dottor di medicina messer Girolamo Donzellino e messer Nascimbene Nascimbeni per provare con testimoniy la lor ubidientia verso il sacro tribunale della santissima inquisitione di Venetia.

Che nel fine di agosto e nel principio di settembre vedendo i sopraddetti che la peste non solamente haveva fatto gran mortalità et faceva tuttavia nelle case circunvicino et contiguo alla cason, ma già era anco entrata in detta casona, i suddetti per vari messi et lettere mandato al predetto reverendo Inqusitore et al clarissimo Foscarino, solicitation di esser mutati in altra prigione et che altro non li fu risposto se non che havessero patientia essendo il padre Inquisitore sequestrato per la morte di più frati. Et essendo già in essa cason morto il casoniero et casoniera di peste et essendo venuti via tre donne ferite del male, che poi sono morte al lazareto solicitarono i suddetti già prenominati signori con lettere e messi ma mai impetrarono altro che questo di sopra cioè che l'havessero patientia.

Che non havendo essi niuno in casa che sumministrasse le cose necessarie, pasti, vino, acqua, né potendo buttar fuori le immondizie quotidiane, mandarono a signor presidenti del sestiero di castello a San Zaccaria per impetrare che a questo loro bisogno fusse fatta provisione, da quanto si hebbe risposta che non volevano far nulla non essendo sua iurisditione.

Che astretti dalla necessità non havendo alcuno sussidio da parte alcuna, cosi esortati da Biasio ministro della santa Inquisizione apersero le porte

della prigione per andare all'uscio della strada e poter tuor dentro le cose necessarie essendo la casa sequestrata, né potendo alcun venir dentro.
Che per dieci giorni continui stetero nella sua prigion in obedienza con tutto che la porta fusse aperta e che [fosse] loro libertà andar dove volevano.
Che volendo un prigioniero Costantino da Osiago fuggire come poi fuggì, condannato alla galea, et volendo anco seguirlo messer Nicolò da Castelfranco imprigionato dall'Inquisizione i suddetti sempre lo essortarono stare in ubidienza et pure stando lui pertinazzo et volendo partir serrorono con catenozzo la porta della lor prigione, facendo lui gran bravata e dicendo queste esser cose da pugnale a che risposero i suddetti che ciò faciano per il suo bene e bisognava ligare i matti come egli si mostrava esser nel fatto e che finalmente persuaso delle lor ragioni si chetò et stette in prigion aperta a ubidienza per tutto il tempo suddetto.
Che in detti giorni che stettero in prigion aperta non solamente erano in pericolo della vita per esser in casa apestata ma anco perché i vicini homini e donne erano morti o siquestrati in più de quelli esser saviti, et i vivandieri della contrada, pastori, fruttaruoli, et altri erano morti o sequestrati.
Che subito aperta la pregione tutti duo i supraddetti mandarono litterae suae al reverendo Inquisitore e al clarissimo Foscarini, avisandoli che la necessità li haveva constritti ad aprire le porte, ma intendevano di voler stare in obbedienza, non voler partir senza licenza, supplicando tuttavia di esser messi in prigion netta, ma non anco per all'hora impetrarono cosa alcuna per attual ruina che facea la peste.
Che essendo morto messer Iulio Trissino et udendo la morte anche esser vicina a loro, di novo pregarono Biasio che facesse sapere alli signori del tribunale il pericolo suo e benché essi piuttosto volevano morir in ubedienza che salvarsi con partir senza licentia, che non di meno confidavano nelle lor signorie che non gli hariano mancato di pietà.
Ch'il reverendo padre Inquisitore havendo inteso le dette parole da Biasio, et a signor essendo stato inmisso in sua conscienza il stato delli sopraditti dal clarissimo Foscarini, si risolse di non lasciarli morire in quella miseria, et vedendo la lor pronta ubedienza li mandò a dire per Biasio, che andassero con sua bona licentia in casa netta et ivi finita la lor contumacia di giorni 22 et al dottor Donzellini che potesse medicare.
Che il ditto reverendo padre Inquisitore per la libertà concessa al dottor Donzellini volse sicurtà di scudi 500 del qual atto surogato messer nodaro presso San Basso adi 24 settembre 1576.
Che finita la contumacia nella prima lor uscita di casa andarono a visitare il padre reverendo Inquisitore il quale di bocca confermò quanto fia

inanzi haveva mandato a dir per Biasio.
Che essendo andato il medico della contrata di San Giuliano nella quale si trovavano i sopraddetti per stanza, fu pregato il Donzellino dal reverendo prete e signori deputati di visitar i poveri infermi e fare dipositioni, il che per il gran periculo che vi era ricusando, fu tanto pregato che per coscienza a lui parve non poter mancare a un tanto bisogno.
Che essendo il ditto dottor intimato per nome del reverendissimo Patriarca chi s'astenisse dal medicare e stesse in casa che egli in questo fu obediente, ma i signori deputati et il clarissimo Bragandino lo assicurarno (la tanta necessità essendo morti quasi tutti li medici) che dovesse servir la contrada, perché essi haviano operato cosi i signori presidenti a Santo Stephano che dal Reverendissimo Patriarca li fusse concessa la licentia.
Che recusando lui, sempre con dire che non voleva disubidire monsignor reverendissimo Patriarca fecero lui fare un mandato penale di 500 scudi se non ubediva in medicar, et fare la depositione per tutto lo sestiero di San Marco.
Che quando a lui fu intimato il ditto mandato chi lo ricusò, se prima quelli signori clarissimi del sestiero non operavano che monsignor Patriarca consentiva a detto mandato: perché in modo che non voleva esser disubidiente a sua signoria Reverendissima.
Che il clarissimo Bolani di nuovo fa intimare il mandato con la detta pena, minacciando di farne esecutione, se non ubidiva, et promiso d'andar da monsignor Reverendissimo Patriarca per impetrar licentia.
Che non potendo il suddetto clarissimo Bolani per le molte occupationi del suo officio andare in persona dal Reverendissimo Patriarca li mandò una lettera richiedendo chel fusse consintito per beneficio della città che il detto medico medicasse.
Che la detta lettera insieme con un'altra dell'istesso tenore scritta al clarissimo signor Danilo Priuli (qual inteso il valor di ditto medico et il bisogno ch'ista nella città di medici volse anche lui far officio con monsignor Patriarca) furono presentate al detto monsignor Patriarca alli 12 decembre 1576.
Ch'il detto dottor Donzellini sempre si è mostrato verso la povertà et infermi amorevole et l'ha medicata con carità et senza premio, anzi l'ha soccorsa con suoi medicamenti gratis, et amor Dei et alle volte anco con la sua borsa.
Che essendo a lui stato intimato che si presentasse alle prigion nove sempre egli ha detto di voler ubedir volentieri, ma che havendo il mandato predetto penale, prigava lo sacro tribunale che lo fusse levato dalle spalle detto mandato.

Fig. 9.1. "*The Plague*" by Davide Fasolo, 2019. This original illustration represents the facts reported above and it has been produced for the documentary: *A Faceless Man: The Faith and Fate of Girolamo Donzellini*, which I have conceived, written and co-directed along with Emma Hinchliffe (PhD candidate, University of Washington) within my Marie Curie project Netdis (2017-2019), Horizon 2020, grant agreement 748645.

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PESTILENCE IN RENAISSANCE PLATONIC MEDICINE: FROM ASTRAL CAUSATION TO PHARMACOLOGY AND TREATMENT

Introduction

Pestilential diseases were a major concern in Renaissance medicine.[1] This period saw regular outbreaks of plague after the fourteenth–century Black Death, as well as unknown deadly fevers and "new" contagious diseases brought from the New World. In facing the epidemic and fatal character of this type of disease, physicians struggled not only to find an efficient therapy, but also to provide a consistent explanation of its origin and nature. To do so, they relied on the abundant literature on plague and pestilence that had flourished from Antiquity, following the medical authority of Hippocrates and Galen.

From the Galenic literature on plague, the idea spread that violent and often contagious affections, such as plague, syphilis and poisoning, required a different cure than the traditional humoral therapy. Rather than considering violent diseases as a disorder of the four qualities, physicians tended to attribute them to a different cause related to the stars, hence suggesting an alternate etiology and treatment. In the Renaissance, Platonic physicians did so by following the philosophy of Marsilio Ficino. The chief representative of the Platonic medical movement was the French physician Jean Fernel (c.1497–1558), professor of medicine at Paris and court physician of Henri II.[2] In his works on Galenic medicine, Fernel asserted that the living body had a divine part related to its soul.

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[1] On plague in medieval and early modern medicine, see Arrizabalaga 1994; Carmichael 2008; Nutton 2008; Stevens Crawshaw 2016.

[2] On the life and works of Jean Fernel, see Henry 2017; Kany & Turpin 2002; Sherrington 1946.

DOI 10.48255/M.9788891320186.10

This vital principle was a source of celestial heat which vivified the organism, and made its physiological functions work. In contrast, the material part of the living body was made of the four elements with which were associated the four qualities and four humors. Whenever adopted or criticized, Fernel's Platonic conception of the living body played a prominent role in early modern medical debates.[3] His works had a lasting influence on early modern physicians with various philosophical inclinations, including Aristotelian, Paracelsian and Cartesian interpretations.

Whereas Fernel's Platonic views on medicine seemed theoretical in nature, they had a practical counterpart regarding the cure of sickness. Not only did Fernel state that the living body had a vital principle which was different in nature from its material constitution, he also suggested an alternative therapy to humoral medicine. In his view, violent and pestilential sicknesses, which affected the body's vital principle, required a treatment based on specific active powers, medicinal ingredients and modes of preparation.[4] This reasoning relied on a set of "occult", that is hidden, causes regarding the origin and cure of pestilence, and its physiological response within the body.

The nature of Fernel's treatment of plague and pestilence is the focus of this chapter. Fernel explored this theme in his theoretical and practical account of "occult" diseases throughout his works. His approach to these diseases in *De abditis rerum causis* [*On the Hidden Causes of Things*] (1548) was above all a philosophical treatment of the concept.[5] Centered on the notion of "occult" causation, his interpretation has been explored by historians of science from the angle of the Platonic philosophy of Ficino. However, it also suggested some therapeutic application, which was further explained in his didactic works included in the *Universa Medicina* (1567). Fernel, indeed, discussed "occult" diseases in his *Pathologia* [*Pathology*], while proposing a dedicated therapy in his *Therapeutices* [*Therapeutics*].[6] These treatises stood as a bridge between his

[3] On the reception of Fernel in early modern medical philosophy, see Hirai 2011; Deer Richardson 2018; Hirai 2005; Calan 2012.

[4] Deer Richardson 1985; Forrester & Henry 2005.

[5] Fernel 2005. On this treatise, see Hirai 2011, pp. 46-80; Deer Richardson 1985; Forrester & Henry 2005.

[6] Fernel's *Pathologia* and *Therapeutices* are included in Fernel 1567, pp. 176-343 and 344-557, respectively.

philosophical reasoning in *De abditis rerum causis* and his practical *Consilia*, a collection of therapeutic advice which were posthumously published.[7]

This investigation will be focused on Fernel's explanation of "pestilential diseases" as a category of epidemic and often fatal diseases, whose outbreak, causes and treatment were challenging to explain in his time. With this in mind, I will trace Fernel's interpretative path from his cosmological explanation of plague and pestilence to his explanation of drug action and its practical impact on therapy. To do so, I will delineate the ancient, medieval and Renaissance medical approaches to these questions, which Fernel synthetized in developing his own pathology, pharmacology and therapeutics of pestilential diseases. In the final section, I will appraise to what extent Fernel's explanation of "occult" causes shaped his therapy of plague. What type of treatment, ingredient and preparation did Fernel recommend for the cure of pestilential diseases? What was the role of practical tools and knowledge, such as alchemy, in these medicinal preparations? Before tackling these questions, I shall now address Fernel's account of pestilence within the category of "occult" diseases.

"Occult" Pathology: The Case of Pestilential Diseases

Since the Antiquity, physicians had attempted to explain the nature and causes of epidemic diseases as part of the category of plague and "pestilence".[8] The Hippocratic treatise *On the Nature of Man* attributed their causes to the corruption of air through some polluted "exhalations", i.e., miasma. Galen, mostly in his treatise *On the Different Types of Fever*, shaped the Hippocratic idea of corrupted air into a theory of pestilential "seeds" in the air, which contaminated people through respiration. He added that the cause of contamination was related to lifestyle, including diet and other parameters, which would be listed in the medieval literature on the "six non–naturals." As the plague took the form of a pandemic in the late Middle Ages, with regular outbreaks between the four-

[7] Fernel 1585.

[8] On medical theories of plague and contagion from Antiquity to the Renaissance, see Pennuto 2020; Nutton 1983; Weill & Parot 2004.

teenth–century "Black Death" and the eighteenth century, physicians maintained the Galenic explanation and ascribed the corruption of air to some astral causation.[9] For instance, a remarkable astrological aspect, such as a conjunction between Mars, Jupiter and Saturn, could bring about the corruption of air that was believed to induce plague and pestilence.

Such a Galenic account of pestilence was the framework that Fernel used in his own explanation of "pestilential diseases" in *De abditis rerum causis*.[10] He further refined it in his *Pathologia*, which was first published in *Medicina* (1554) as a didactic and systematic work on physiology, pathology and therapeutics. In the following sections, I consider Fernel's amalgamation of ancient and medieval explanations of pestilence, from astral causation to modes of transmission and infection, in order to frame his philosophical explanation of pestilential diseases within the broader category of "occult" diseases.

The Disposition of the Stars

Fernel's account of "pestilential diseases" (*pestilentes morbi*) included violent diseases such as bubonic plague and other varieties of fatal "pestilential fevers". It also comprised minor affections, mostly childhood diseases resembling measles (*exanthema*) and chickenpox (*ecthyma*). In the same way as bubonic plague, these affections were considered as diffused through the air and accompanied by a rash, in particular, blotches and blisters.[11] However, they were harmless to children and rapidly dissipated.[12] Outside of the easily recognizable plague and childhood diseases, other types of "pestilential fevers" could pass unnoticed with mild

[9] On astrological explanation of plague in scholastic medicine, see Weill–Parot 2004.

[10] On Fernel's pathology of the total substance in *De abditis rerum causis*, see Deer Richardson 1985; Forrester & Henry 2005.

[11] Fernel 1567, p. 181: "Sunt et alii leviores ut exanthemata tum rubra, tum purpurea, quae summa cute maculis minime extuberantibus efflorescunt". See also Fernel 2005, pp. 556-557.

[12] Fernel 1567, p. 258: "Utriusque sua propriaque causa in aere: qualitas quippe maligna diversi mitiorisque generis quam quae carbunculum bubonemque pestilentem ingenerat: proinde in infantes ac pueros, non autem in seniores, nisi ferocior immaniorque sit, invadit".

symptoms, such as thin and rapid pulse, indigestion, insomnia and fatigue, which were followed by a quick and unexpected death.[13] Pestilential fevers were more easily detectable when accompanied by a secondary infection. In any case, they did not affect every individual but only those with a certain constitution that was, however, impossible for physicians to determine.

To explain the sudden outbreak of pestilential diseases, Fernel tacitly followed the scholastic accounts of plague in ascribing pestilence to the infection of ambient air by some astral influence.[14] In this regard, he insisted that meteorological and insalubrious factors, which had been defined as "lower" celestial factors since Avicenna, were only aggravating circumstances. They did not help to prognosticate pestilence, which was produced by the only disposition of the stars.[15] Such an astral influence explained the violent and fatal dimension of pestilence and, most importantly, its unpredictability and mutability over time. Fernel indeed noted that some plagues of the past, which were reported in the medical literature, had vanished, while unprecedented diseases appeared in his own time. Future generations, Fernel concluded, would observe more of them in time to come.[16]

In the medical tradition, the mention of astral influence was not limited to the explanation of plague as it was part of a broader approach to physiology, pathology and therapeutics. Since Hippocrates and Galen, the configuration of planets and stars, for instance, the phases of the Moon, was consulted to prognosticate the paroxysm or "crisis" of cyclic diseases, most notably, the "critical days" of fever.[17] As a typical Renaissance physician, Fernel was familiar with the use of astrology for medical

[13] Ivi, p. 25; Fernel 2005, pp. 574-577.

[14] Fernel 1567, p. 181: "Hi ex aere coelestium corporum viribus inquinato suscitantur, ut febris pestilens, et pestilens bubo […]".

[15] Ivi, p. 257: "Ex his igitur praesagiri potest annum gravem calamitosumque fore, in quo putridi malignique morbi grassentur. At vere pestilentem annum fore, non hinc praevidere licet, sed ex sola syderum commistione, quae illius est procreatrix". See also Fernel 2005, pp. 548-549, 572-573.

[16] Fernel 1567, p. 181: "[…] alios vero alia secula protulerunt, qui veterum oblivione obruti extinctive iam sunt, alios futuris seculis posteritas animadvertet, quum novae syderum concursiones permistionesque illorum effectrices obtingent". See also Fernel 2005, pp. 568-569.

[17] On Fernel's account of celestial influence in *De abditis rerum causis*, see Henry 2013; Saif 2011; Hirai 2011, pp. 46-80.

purposes, to which he applied his extensive knowledge of mathematics.[18] In his early work on astronomy, the *Monalosphaerium* (1526), he discussed the critical days of fever according to Hippocrates, Ptolemy, Galen and the Spanish scholar Abraham ibn Ezra (ca. 1092–1167).[19] Fernel also proposed different ways to calculate individual "horoscopes", i.e., birth charts, in reference to the German astronomer Regiomontanus (1436–1476). From this, we can infer that Fernel likely used horoscopes to refine the diagnosis of his patients' native constitution, and forecast the evolution of their sickness through astrological prognostication.[20] Moreover, in the context of his discussion on pestilential diseases, Fernel identified the cause of the epidemic to a specific "disposition" of the stars. Along the lines of scholastic physicians like Pietro d'Abano (1250–1316), he thought that the stars could interfere with living beings by their light and movement into the air in such a way to influence longevity and health.[21]

However, Fernel neither provided details on how the stars infected the ambient air, nor gave an example of an astral configuration heralding pestilence. In his view, the astral influence on the living was a type of knowledge nourished by secrecy and wisdom.[22] Although it did not allow physicians to anticipate pestilence, it could help them to explain its cause and to give a suitable treatment after the outbreak. Fernel buttressed this explanation with the authority of Hippocrates and Galen. Both ancient physicians, he recalled, attributed a "higher" celestial origin to the infected miasmas that transmitted plague. Such a "hidden" and invisible provenance was imperceptible to the senses.[23] In addition, Hippocrates and Galen more broadly stated that the stars were the cause of the "critical days" of diseases, for instance, through planetary aspects of

[18] On Fernel's early training in mathematics, see Henry 2011.

[19] Fernel 1526, ff. 10r–13r, 21r–23r.

[20] See Fernel's astrological insight into premature birth: Fernel 1585, pp. 118-119; Sherrington 1946, pp. 37-38.

[21] Fernel 2005, p. 572: "Gravis est eorum stupiditas qui sidera nihil in aera nisi calorem aut frigus, imbres aut siccitatem lumine motuque suo inducere contendunt. Si illa bene constituta omnium vitam tuentur ac conservant, cur male constituta vitae non incommodent? Illinc prima et praecipua est rerum omnium salus et conservatio, illinc quoque interitus".

[22] Fernel 2005, p. 572: "O vere foelices qui secretiore hac cognitione sapientissimi fiunt: qua neque ad praecavendos, neque ad persanandos pestilentes morbos est ulla praestantior".

[23] Ivi, pp. 544-545.

the Sun, solstice, equinox, and the rising of major stars and constellations. For Fernel, this confirmed that the stars were the hidden power which disseminated the toxic miasma responsible for pestilential diseases. The latter propagated due to a particular type of contagion through malignant "seeds" within the ambient air.

Poisonous Seeds and Vapors

In Fernel's intention, the term "pestilential" (*pestilens*) seemed to take the broad sense of a fatal epidemic disease. However, other affections of this kind which were rife in the Renaissance, such as syphilis and leprosy, fell into the separate category of "contagious diseases" (*contagiosi morbi*) to the extent that they spread by the touching of skin – *contagio* meaning "contact" in Latin. Fernel's category of "pestilence" thus suggested some invisible and intangible form of contagiousness, which was mediated by the ambient air. For him, there was no doubt that the very substance of air could be the substrate of violent diseases. If polluted by some astral configuration, the "seeds" (*semina*) of air could penetrate the body during respiration as well as perspiration, i.e., through the skin pores.[24] These "seeds of pestilence" (*pestilentiae semina*) then contaminated the body by internal contact (*contagio*).[25]

With his theory of plague seeds, Fernel synthetized the previous explanations that were provided in the Antiquity.[26] Not only Galen suggested the existence of seeds in his medical approach to plague and pestilence, Lucretius, in his poem *On the Nature of Things* (e.p. 1473), founded his atomistic philosophy on the notion of seeds. As discrete components of nature, they were involved in the generation and corruption of all things, including the propagation of diseases. In Fernel's time,

[24] Fernel 1567, p. 257: "Pestilentis autem febris causa est pernicies venenataque qualitas e sublimi coelitusque in aerem demissa, quae quasi furibunda passim involat in vulgus. Quia enim pestilentiae semina aeri inspersa inspiratione perspirationeque intro subeunt, si cor affectioni praeparatum est, id continuo, inde vero arteriarum spiritus, postremo humores corpusque universum labefactant".

[25] Ivi, p. 189: "[…] pestilentiae seminibus vel coelitus immissis vel in se genitis polluitur labefactaturque. Haec igitur una cum aere quem spiritu ducimus permanant in omne corpus, et contagione tum spiritus, tum humores suo quaeque modo contaminant, et varios eosque fere occultos morbos proferunt".

[26] Nutton 1983.

the Italian physician Girolamo Fracastoro published an elegant poem on syphilis in the fashion of Lucretius, *Syphilis sive Morbus Gallicus* [*Syphilis or the French Disease*] (1530).[27] The poem reported the contagion of the venereal disease through airborne seeds as particles which aggregated into "seedbeds" (*seminaria*) and propagated inside and between bodies. Unlike Lucretius, Fracastoro reframed this reasoning in a Galenic framework by substituting the traditional interpretation of "occult" sympathy to the atomistic notion of vacuum in order to explain the contact between seeds. Moreover, as Hiro Hirai has shown, Ficino was another major source for the medical theories of morbid seeds in the Renaissance.[28] The Platonic cosmology that was presented in Ficino's *De vita coelitus comparanda* (1489) explored the notions of form, seed and seedbeds as emanations of the world–soul, which were fundamental in Fernel's *De abditis rerum causis*. In this sense, Fernel merged the Galenic, Lucretian and Ficinian interpretations of seeds for his own account of pestilential contagion through airborne minute entities originating from the heavens.

According to Fernel, the contamination by the pestilential seeds in the air was comparable to the ingestion of poison through breathing.[29] By way of the infected seeds in the air, this pestilential poison, in the form of a malignant "vapor" (*vapor*), diffused through the lungs into the heart, the arteries and the whole body. It progressively infected the heart, the physiological "spirits" (*spiritus*) and the humors by putrefying them, before eventually corrupting the body's substance.[30] By "putrefaction", Fernel meant a progressive decomposition of the body's temperament due to the fading of its heat. As the body heat got weaker, humors immoderately increased and putrefied, with a fetid smell, and eventually dried up. The final phase of corruption designated the immediate destruction of the body's substance.

Concurrently with the notion of morbid seeds, the theory of plague as a form of poisoning was widely diffused in Renaissance medicine.[31] As

[27] On Fracastoro's Lucretian theory of contagion, see Nutton 1990; Beretta 2003; Maurette 2014.

[28] On the reception of Ficino's theory of seeds in Renaissance medical philosophy, see Hirai 2006; Hirai 2005.

[29] Fernel 2005, pp. 550-551; Fernel 1567, p. 256.

[30] Fernel 2005, pp. 532-535.

[31] On medieval and Renaissance medical theories of poison, see Chandelier 2009; Gibbs 2018.

Joel Chandelier has pointed out, the Italian physician Christophoro degli Onesti (c.1320–1392) was one of the earliest figures to merge, in his treatise *De venenis* [*On Poisons*], the notions of plague, poison, substantial form and astral causation by synthetizing ancient and medieval authorities on these questions. The main source was Galen for his approach to the "total substance" (*tota substantia*) of bodies as the cause of properties that were remarkable yet unexplainable from the perspective of humoral medicine. For Galen, pharmacological substances such as purgatives, poisons and antidotes had a similar mode of action based on some magnetic attraction or "sympathy" from their total substance, which was known only by experience. Avicenna integrated this reasoning into the Aristotelian theory of matter–form by highlighting the relationship between the "total substance" and the "specific" form of bodies to explain their particular powers in a pharmacological context.[32] Following both medical authorities, Pietro d'Abano ascribed a celestial provenance to the specific form, in particular, that of poisons, in support of his astrological view on medicine.

In his turn, Fernel assimilated the Galenic and Avicennian doctrines in a broader medical work that included, on top of the physiological and pharmacological powers of the total substance, the action of pestilence as a form of poisoning originating from the stars. He presented this view in a cosmological framework which was more in line with his time, by following the Platonic philosophy of Ficino in order to frame his interpretation of "occult" medicine.

Total Substance and Innate Heat

As Fernel noted the rapid propagation of pestilential fevers, he acknowledged the difficulty of explaining what made them so prompt to infect the body. In his view, this was due to the "occult" nature of pestilence.[33] This type of affection was included, along with contagious (*contagiosi*) and poisonous (*venenosi*) diseases, in the broader category

[32] Weill & Parot 2004; Chandelier 2009; Gibbs 2018; Copenhaver 1984.

[33] Deer Richardson 1985; Forrester & Henry 2005; Gibbs 2018. On astral and "occult" explanations in scholastic and early modern medicine, see Weill & Parot 2010; Hirai 2014.

of "occult" diseases.[34] Unlike ordinary illnesses, they were not related to some humoral imbalance, but affected the body's total substance related to its substantial form.[35] The terms "occult" and "hidden" emphasized that such a phenomenon related to the total substance went beyond the reach of reason and the senses, and could only be known by experience.

In Fernel's medical philosophy, the total substance of a living body was in close connection with its vital principle, the "innate heat" (*calidum innatum*). Throughout his works, Fernel insisted on the divine and celestial origin of innate heat, which was transmitted to all living beings at birth. This explanation was anchored in his Platonic cosmology, which was expounded in *De abditis rerum causis*.[36] In his view, God created living beings from the elements and infused them with celestial properties, which were transmitted through their seed. It was from this very seed, which contained a celestial "spirit" (*spiritus*) and heat of divine origin, that the "occult" properties of beings originated. It was also through this seminal principle that living beings acquired their substantial form. The latter came from a heavenly instantiation, which Fernel compared to Ficino's world–soul (*anima mundi*), Avicenna's giver of forms and Aristotle's nature. From a physiological point of view, the "innate heat" of the living body was an instrument of the soul to make all the physiological functions work. These functions operated through the three main faculties of the soul – vegetative, sensitive and rational – which had their corresponding natural, vital and animal "spirits" related to the liver, the heart and the brain, respectively.

Defined as a vital principle related to the body's substance, the innate heat was the target of "occult" diseases of the "total substance", including pestilence. For this very reason, pestilential diseases acted differently from common illnesses, which were caused by a humoral disorder. In attacking innate heat, they first harmed the heart and the vital spirit. Then, they were particularly fatal in corrupting and destroying the vital principle of the patient, and ultimately, its substantial form. Nonetheless, the physician could count on an equally "occult" pharmacy to counter the poisonous effects of pestilence. The active powers of these drugs were expounded in Fernel's *Therapeutices*.

[34] Fernel 1567, p. 181; Fernel 2005, pp. 554-555.

[35] Fernel 1567, pp. 180-181: "Totius vero substantiae nomine et insitum spiritum, et divinum illius calorem, et facultates ipsamque formam complectimur. Totius substantiae morbi sunt, qui partium substantiam primum et per se oppugnant".

[36] Fernel 2005, pp. 696-701. On innate heat in Fernel's medical philosophy, see Hirai 2005, pp. 83-106; Hirai 2011, pp. 46-80.

The Pharmacology of the Total Substance

Fernel's pharmacological approach to "occult" diseases, including plague and pestilence, was rooted in the longstanding explanation of drug powers established by Galen.[37] In his pharmacological works, Galen defined the properties of drugs according to three "faculties". The first faculty was related to the remedy's "temperament", that is its primary qualities (hot, cold, dry and moist). The second faculty was associated with its "matter", i.e., its secondary qualities related to its material texture, for instance, thick or thin, liquid or solid. The third faculty depended on the drug's "total substance" related to its substantial form.

The tripartite order of faculties shaped the classification of drug powers and corresponding type of disease. Common diseases were considered as caused by an imbalance of temperament or matter. Less frequent forms of affections, which were violent, fatal and at times contagious, were allegedly caused by a corruption of the total substance. In any case, the treatment consisted in a "cure by contraries", by administering a remedy which was opposite in primary or secondary qualities, or in substance. Following this Galenic framework, medieval Arabic physicians, such as Rhazes and Avicenna, brought important pharmacological contributions. They discussed the dosage of drugs, the quantification of their powers by degrees, and the relationship between the total substance and the Aristotelian concept of substantial form.[38] The Galenic and Avicennian accounts of drug powers were further transmitted in the West by late medieval and Renaissance physicians, from Pietro d'Abano to Leonhart Fuchs.

Fernel provided a synthesis of Galenic therapy and pharmacology in his *Therapeutices universalis seu Medendi rationis libri septem* [*Universal Therapeutics or The Seven Books of Method of Treatment*] (1567).[39] Al-

[37] On Galenic pharmacology, see Blank 2018; Ausécache 2006; Debru 1997.

[38] On the Latin-Arabic theory of drug powers, see McVaugh 2009.

[39] The three first books of the *Therapeutices* were first published in Fernel's *Medicina* (1554). The complete version including seven books was posthumously published in the *Universa Medicina* (1567).

though he mostly cited ancient authorities to prove his point, the form and content of the treatise were based on Avicenna's *Canon*.[40] Fernel's *Therapeutices* expounded on the range of cures that were used in early medicine according to the Galenic tradition: bloodletting, internal or external purgation, and medication. In the following sections, I examine Fernel's pharmacological account regarding the treatment of pestilential diseases by covering the drug powers associated to the total substance, the types of "occult" drugs and their efficacy during therapy.

Occult Properties and Sympathy

Fernel continued the medieval and Renaissance discussion on the powers of drugs in relation to their qualities and substantial form, following the Aristotelian physics of matter–form. As he explained, drugs transformed the body's natural constitution thanks to their qualities, which were present in "potentiality". This Aristotelian term indicated that drug powers were not operative yet but needed to be activated by the body heat.[41] At that moment, they were able to expand their own temperament and to act by contact (*contagio*) with the body part. Through some internal "mixture", the drug's primary or secondary qualities opposed those of the body in order to bring its constitution back to a moderate state.[42]

For Fernel, the cure by contraries and the physics of matter–form remained appropriate to explain the powers of "occult" drugs, though in terms of total substance rather than primary or secondary qualities.[43] On this point, he developed the Avicennian approach to the specific

[40] In a similar way to *Canon* 1.4, the three first books of the *Therapeutices* started with generalities before tackling bloodletting and purgation. The four following books discussed simple and compound drugs in the same vein as Avicenna's *Canon* 2 and 5.

[41] Fernel 1567, p. 409: "Calor enim noster medicamentum dum subigit, eius naturam, temperamentum et alias quascunque vires detegit et explicat: hoc vero quasi proritatum communi rerum omnium conditione reluctatur et obsistit, atque vicissim contagione corpus afficiens, omnes in id vires suas expromit".

[42] Ivi, p. 346: "Nam quum illa vel permistione vel contactu congrediuntur, mutua actione sese obtundunt, suasque vires remittunt, ac neutrum omnino in alterius naturam, sed in medium quiddam facessit".

[43] On Fernel's pharmacology of the total substance, see Deer Richardson 1985; Gibbs 2018, pp. 195-204.

form that was discussed in the *Canon*.[44] According to Fernel, the main active power of "occult" remedies, including purgatives, antidotes and noxious drugs, came from their substantial form, which caused its hidden properties as a "third" faculty.[45] It did so by opposing the poisonous substance through "antipathy" or by supporting the body's substance through "sympathy", rather than by processing a mixture of qualities. Following this reasoning, Fernel considered that the therapy of the total substance required to oppose the remedy's total substance to that of the noxious substance. By acting through their substance, "occult" drugs and diseases had powerful effects as much for curing as for poisoning the body. In both cases, they targeted the body heat, the spirits and the vital organs.

The sympathy and antipathy that were operated by "occult" drugs involved the same process of "similitude of substance". Following Hippocrates and Galen, Fernel took the example of purgative drugs to define the similitude of substance as a phenomenon of attraction between two substances, in the same way as the roots of a plant drew on nutriment, the magnet attracted iron, and amber attracted straw.[46] By similitude, Fernel meant resemblance rather than identity. In fact, the remedy's substance needed to be stronger than the body part to attract. In the medical tradition, this type of properties was defined as "occult" to the extent that it could not be detected by color, taste, odor or any sensory quality, but only through its noxious or healing effects.

As Fernel explained the active powers of "occult" drugs, he still had to justify their presence within healing and poisonous substances. According to his interpretation of physiology and pathology, these "occult" properties came from the innate heat, as a vital principle related to the total substance of living beings. However, the innate heat disappeared after death, leaving the sole material body that was made of elements. This meant than any remedy made of dry plants or dead

[44] On Avicenna's concept of specific form in pharmacology, see McVaugh 2003; Weill & Parot 2004; Chandelier 2009; Gibbs 2018; Copenhaver 1984.

[45] Fernel 1567, p. 416: "Tertia medicamentorum facultas de qua mihi dicendum restat, non e temperamento, non e materia, sed e tota rei substantia atque forma primum ac per se proficiscitur: ac proinde occulta totius substantiae proprietas appellari solet".

[46] Ivi, p. 391: "Quanquam igitur attraction [...] totius substantiae, similitudine fit, quae tamen a medicamentis purgantibus est, una similitudinis proprietate completur, qua et stirpes succum e terra sibi idoneum, et unaquaeque corporis particula id quod in sanguine sibi familiare et conveniens est, et lapis heraclius ferrum, et paleas succinum prolectat."

animals would be devoid of medicinal properties of the total substance. However, Fernel argued, vegetal and animal bodies partially kept some secret powers after death. These powers were "implanted" in their body and remained in their total substance, as was testified by the powers of cooked ingredients.[47] Nonetheless, these hidden properties needed to be activated and preserved by a specific preparation, which will be further considered in the last section of this chapter. In the meantime, I will now turn to the type and effects of "occult" drugs.

Types of "Occult" Drugs

Fernel expounded diverse types of "occult" drugs, which acted through their third faculty related to their total substance. Established in Galenic pharmacology, these drugs aimed to move the targeted humors by purgation or evacuation, or to transform the substance of the body part.[48] As Fernel explained, they had the ability to operate antipathy towards the disease by splitting up its total substance.[49] A common example of these drugs was purgatives (*purgantia*), which caused vomiting or defecating. Some were noxious, e.g., scammony and colocynth, while others were "neutral", e.g., rhubarb and agaric. Benign purgatives included medicinal food, such as prunes and violets. The "evacuative" drugs (*evacuantia*) had a similar effect to that of purgatives, but attracted a specific humor, for instance by drawing it from the brain through the mouth, the palate or the nostrils, or from the womb through the cervix. Evacuative drugs could also include alexiteres and *alexipharmaka* (antidotes), which attracted or repelled poison by similitude of substance.

[47] Fernel 2005, p. 708: "Multorum nihilominus vires eousque penetraverunt, ut non solum in spiritu et in tenui substantia, verum etiam in crassiore materia et in tota substantia firmius inhaerescant, permaneantque abeunte totius forma, illiusque temperamento dissoluto. Nam quae ex herbis, aut ex aliis purgantibus medicamentis aqua vaporario elicitur, purgandi vim etiamnum retinet, aut deleteriam si herbae in deleteriis fuere".

[48] On purgative, evacuating and alterating drugs related to the total substance, see Fernel 1567, pp. 416-417.

[49] Fernel 2005, p. 732: "Occultis vero morbis obsistunt, quae antipathia et totius substantiae dissidio vires habent".

Fernel explained the mode of action of purgatives and evacuative drugs during digestion, at the level of humors and "vapors".[50] Their hidden property remained in potentiality and needed to be activated by the body heat to attract the targeted humor. The matter of purgative drugs was broken up and warmed up by the stomach heat, which released the drug's third faculty. The medicinal substance in the stomach and the intestines attracted the noxious humor in order to evacuate it naturally. Through a purgative "vapor", it spread through "hidden", that is minuscule, ducts, and finally reached the poison. The vapor "cut" the latter and prompted the body part to evacuate it by antipathy. As for the drug material, it did not get through the poisonous humor and might even remain intact in the stomach or in the intestines, as shown in the vomit or feces.

In addition to purgatives and evacuative remedies, "alterative" drugs (*alterantia*) destroyed the total substance due to their hidden property. They comprised poisons and antidotes. By "poison", Fernel meant any noxious substance acting on the body's total substance due to an "occult" property. Their substance attacked the vital parts and dissipated their force by overwhelming the body heat and corrupting the substance of all faculties. In contrast, antidotes counteracted the action of poison by overcoming its total substance. They could cure or prevent pestilential diseases, heal venomous bites, or act on specific body parts by similitude of substance, for instance sage on the brain, bugloss on the heart and agrimony on the liver. Conversely, some drugs were toxic only to specific parts by similitude of substance, e.g., sea hare on the lungs and cantharides on the bladder.

Across Fernel's theoretical and practical works, such categories of purgatives, evacuative and alterative drugs were present in the pharmacological prescription for pestilential diseases. They were accompanied by a series of recommendations regarding the therapeutic method.

[50] Fernel 1567, p. 393: "Dum enim ventriculi calore medicamentum teritur, calefit, omnique ratione exagitatur, tacita eius facultas quasi solutis vinculis exurgens se promit profertque vires novas. Ac tum vapor ea ipsa facultate praeditus illinc prosiliens, per caecos occultosque ductus in omnes corporis partes quoquoversum effusus, ad noxium humorem pertingit. Atque is humorem iamdiu fortasse parti consuetum ac quiescentem, acrimonia incidit praeparatque, et adversa qualitate partis naturam acrius stimulat proritatque ad excernendum".

Method, Observation and Experience

Fernel proposed his *Therapeutics* as a methodical and legitimate approach to therapy, which reflected the superiority of medical knowledge to that of apothecaries and herbalists.[51] In his view, a firm knowledge of drug properties and the patient's temperament were fundamental to prescribe an efficient treatment. As stated by the Galenic tradition, the physician had to define the remedy's type, quantity and use according to the patient's constitution and lifestyle.[52] Moreover, the knowledge of drug powers relied on the use of both reason and experience, in particular, through the senses and constant observation.[53] Fernel followed this reasoning by insisting on the role of reason and method in planning therapy and composing remedies.

However, the diseases and drugs related to the total substance escaped as much the senses as reason. Only their effects could be known by observation and experience. Nonetheless, Fernel advised, the physician could still apply a method to appraise the efficiency of his "occult" therapy.[54] This method included a series of therapeutic steps covering the treatment of the sick patient and of the corrupted air.[55] Each of the applied remedies acted through its total substance by cleaning the ambient air and, if needed, the patient's wounds, by purging the body from the infection and by fortifying the "spirits".

The first step of Fernel's method for curing pestilence consisted in assessing whether the patient suffered from a complicated form of "occult" disease, that is a disease accompanied by a secondary infection. The complications required to be treated before the application of any

[51] Fernel 1567, p. 348: "Haec non iam simplex, sed methodica curatio est, quae non solis remediis, sed via utendique ratione completur. Hac una maxime herbariis atque pharmacopaeis, quibus etiam cognita est remediorum materia, medicus est praestantior".

[52] Fernel 1567, p. 351: "Expugnando morbo paria quodam modo opponenda adhibendaque sunt remedia. Ut tria erant ex quibus medendi ars constituebatur, remedii genus, quantitas et utendi ratio; ita tria sunt ex quibus illa nosse oportet, affectus species, magnitudo et partis cui insidet conditio. […] Hic autem ex laborantis natura, ex aetate et consuetudine deprehenditur".

[53] On the Galenic method in pharmacology, see Jacques 1997; McVaugh 2003.

[54] Fernel 2005, p. 722: "[…] facultates quae totius substantiae proprietate fiunt, a methodo et ratione alienas esse […]. Illas enim non ratione ab odore vel sapore, sed sola experientia invenire possis. […] Itaque occultae facultates quae manifesta demonstratione sciri haud possunt, methodo tamen et ratione ad morborum curationem adhibendae sunt".

[55] Ivi, pp. 724-733.

"occult" remedy. Then, the physician could move on identifying and healing the efficient cause of the pestilential disease. The ambient air was purified by a fire, perfume or vapor with strong properties of the total substance. Inhalation was recommended to clean the patient's lungs and heart. The poisonous substance of disease within the body was also treated by a suitable regimen and medication in order to drain the infection before it got stronger and reached the viscera. If the patient had sores, such as bubos, these were extracted by ligature, suction or poultry, whose substantial heat and spirit attracted the poison. A sponge soaked with a solution of salt and vinegar was applied to the clean wound. Further surgical treatment by scarification, cupping glasses, plasters and cauterization might also be used to disinfect the wounds. The last step was to remove any remaining infection with a "manifest" drug with first and second faculties, for instance, cold and astringent potions.

Fernel considered that his therapeutic method required to be adapted to the patient's individual condition in order to ensure its safe and effective process. The investigations on the effects of "occult" drugs were to be gathered and confirmed by long observation and the medical authorities. In the case of hidden drug properties, Fernel specified that the term "experience" designated the observation of recurring effects regarding a same phenomenon over time.[56] This implied that the physician had to try the effects of new drugs many times before determining if it actually had third faculties. The detailed appraisal of the remedies under trial remained at the appreciation of the physician.

To this traditional protocol, Fernel added that the knowledge of the stars had a critical impact on therapeutic method.[57] From his account of pestilence, we know that he stated the influence of celestial bodies on health and longevity. Although Fernel acknowledged that astrology had been discredited by superstitious believes, he insisted on its relevance for medical purposes, since the properties of natural beings were maintained by the motion and powers of celestial bodies. Most notably, the stars affected living bodies through their vital principle, the "innate heat",

[56] Fernel 1567, p. 417: "Experiri est quippiam effectu probare. […] Haec igitur rerum notio quae ex crebra eventuum observatione habetur, proprie dicitur experientia […]. Non quod semel duntaxat, sed quod identidem atque similiter et eadem rerum omnium concursione saepius evenerit, experientiam gignit". See also Fernel 2005, pp. 734-735.

[57] Ivi, pp. 700-705.

which had a celestial origin. Such an astral influence was particularly important for medical practice. Each body part, disease and remedy were impacted by a specific combination of stars and planets.[58] In pharmacology, this suggested that the moment of picking, storing and using plants as medicinal "simples" was conditioned by the configuration of the stars. However, in the same way as Fernel did not provide practical details on the astrological pattern for pestilence, he did not develop the connection between pharmacy and astrology any further, nor did he mention this question for the treatment of pestilence in his *Consilia*.[59] In closing my investigation on the treatment of pestilential diseases, I shall now turn to the latter treatise in order to appraise how Fernel applied his therapeutic method.

Curing the Patient: A Case Study on Sweating Fever

Whereas diverse explanations of the origin and transmission of pestilence had flourished from Antiquity to the Renaissance, its very cure remained unchanged over centuries.[60] As Vivian Nutton has pointed out, the pathology of plague and pestilence, in particular, the notions of seeds, "occult" cause and total substance, was merely an intellectual framework for the learned physician.[61] In medical practice, the impact of this theoretical framework was limited to focusing on the multiple ways of treating the patient and purifying the ambient air. If this observation is relevant in the case of Fernel's pharmacological and therapeutic considerations, his therapy was remarkable for its consistent application of the "occult" explanatory framework to every step of the process, including the choice and preparation of ingredients.

58 Ivi, pp. 704: "[…] recte philosophantium sententia […] docetque pariter qui planetae et quae sidera unicuique corporis particulae, et quae unicuique tum animantium tum stirpium generi praesint: quae siderum consociatio morbos ingeneret, quae salutaria profligandis illis remedia ferat. Hac inspectione cognitioneque rerum, mox ratione comprehenditur, quod omni tempore rerum proprietates cum mundi spiritu illabuntur, insuntque rebus efficacissimae, et quando herbas stirpesque singulas legere, quando componere, quando ad curationem adhibere expediat".

59 Fernel only alluded to finding the right time for bloodletting and purgation according to the stars in his *Therapeutics*: Fernel 1567, pp. 378 and 402.

60 On plague treatment in medieval and early modern times, see Stevens Crawshaw 2016, pp. 151-181; Nockels 2007; Heinrichs 2017.

61 Nutton 1983.

In his *Therapeutices*, Fernel recommended different types of treatments and remedies to heal "occult" diseases of the total substance, including some dedicated drugs to pestilence. But how exactly should a doctor select and apply these various drugs and treatments? Fernel provided an answer to this question in a practical case of pestilential illness.[62] The treatment, which he gave in 1550, along with two of his colleagues at Paris, Jacques Houiller (c.1498–1562) and Jacques Dubois (1478–1555), was presented in a collection of practical recommendations, the *Consiliorum medicinalium liber* [*The Book of Medicinal Advice*], posthumously published in 1582 and re-edited till 1644.[63] Rooted in the eponymous medical genre, Fernel's *Consilia* were a collection of therapeutic advice requested by a series of former patients. By summarizing the causes, symptoms and treatment of common and remarkable illnesses, the collection anchored medical practice in theory by offering didactic insight into pathology, pharmacy and therapy.

Fernel's reported patient, the English ambassador (*legatus Anglicus*), was concerned with the "English plague" (*pestis Anglica*), namely the "sweating sickness" that had been spreading in Europe from the late fifteenth to the mid–sixteenth centuries.[64] While the very nature and outbreak of this disease have remained mysterious to historians, the symptoms were described as a mixture of cold, fever and exhaustion, leading to a quick death. As Fernel introduced the case, he did not fail to explain the nature, cause and treatment of this affection as a pestilential disease related to the total substance. Formulated as a detailed prescription, the therapeutic protocol served to either prevent or cure the disease.

Therapeutic Procedure

As Fernel explained, the English plague was an epidemic fever with the remarkable symptom of sweating.[65] It caused the decay of humors,

62 Fernel 1585, pp. 137-140.

63 On Fernel's *Consilia*, see Pittion 2002. On the medical genre of the *Consilia*, see Agrimi & Crisciani 1994.

64 On the sweating sickness, see Carlson & Hammond 1999.

65 Fernel 1585, p. 137-138: "Pestis Anglica haud ita multis ante annis nota omnium acutissima. Nomen a symptomate insigniori sudatione nacta, sive in humorum sive in spirituum, sive in amborum putredine consistat, Epidemia omnino est. Corruptoque caeli tractu a ventis, halitibusve terris, aut caussa alia venefica plane in corpora magis humida atque excrementosa, ut pestes aliae saevit, et saepius, et periculosius".

spirits and, in the most serious cases, of the whole body. As a pestilential disease, it was due to the corruption of the heavens transmitted by the air through the wind, earthy exhalations or another poisonous cause. The therapeutic protocol described in the *Consilia* matched Fernel's method for curing the "occult" diseases, including pestilence, in *De abditis rerum causis* and *Therapeutices*. It consisted in cleaning both the ambient air and the patient's body as well as giving a specific medication and diet.

The physician had to prevent or repel the poisonous quality of air, whose total substance had pestilential properties.[66] The cleaning of air was ensured by ventilating the room with fans and by making a fire in the patient's bedroom. The materials used for the fumigation mostly included dry leaves, flowers, seeds and roots of fragrant plants. Such a purified air, Fernel insisted, should be kept clean and free of any human breath transporting the reservoir or "seedbeds" (*seminaria*) of pestilence.[67]

The purification of air was coupled to internal cleansing in order to empty the body of any excremental or decaying substance.[68] A purgative potion, based on aromatics, spices and sugar, was to be taken the first day of therapy on an empty stomach. Six days later, a bloodletting should be applied to the basilic vein of the arm or, if the patient was averse to phlebotomy, a light diet. Additional medication in the form of pills composed of plants, spices, gum resin and clay, was advised up to three times a week.

Besides purgatives, a fortifying treatment was recommended to help the vital organs and faculties to counter the malignant contact of air.[69] As Fernel claimed, his recipe of *alexipharmakon*, approved by both reason and experience, was based on a complex mixture of theriac, plants, spices,

[66] Ivi, p. 138: "Aerem corruptum, et tota sua substantia qualitatibusque pestilentibus vitiatum in corpus tum recipi prohibebis, si loca eo aere pestilenti contaminata intervallo etiam longo vitabis".

[67] Ivi, p. 138: "Hunc vero aerem ea cura praeparatum cave hominum halitibus conspurcari, ne forte inter eos sint, quibus mali huius rudimenta, et veluti seminaria circumgestentur".

[68] Ivi, p. 138: "Corpus tum paulo calidius ac humidius contra hanc luem munies, ac veluti adamantinum reddes, si vacet excrementis aut putridis, aut ad putredinem paratis, et bene totum perspirabile reddatur. Quae ambo praestabunt vacuationes paucae, et victus ratio idonea".

[69] Ivi, p. 139: "Quanquam vero haec purgantia etiam robur addant partibus nostris principibus, in quibus sunt facultates summae, quorum actio est nostra vita: tamen propriis etiam alexipharmacis sunt velut armandae, ne locum dent ullum malignae huius aeris contagioni, cuiusmodi esse haec duo praestantissima constituimus ratione atque experientia inventa ac comprobata".

and minerals, including precious gems and gold. Prepared by distillation, these ingredients were to be taken up to three times a week.

Lifestyle was also part of the recommendations to prevent or cure pestilential diseases.[70] To evacuate the malignant sweat, gentle workout was practiced in the morning with an empty stomach. Moreover, the patient should have a moderate diet. Meat, mostly in the form of roasted game birds, needed to be prepared in the juice of citrus fruits and seasoned with aromatics. Fish should be dry and crumbly after cooking. Whereas red or white wine of mediocre strength was allowed, beer was to be avoided because of its moistening and melancholic properties. Milk was to be avoided too because of its tendency to become corrupted, although old cheese was permitted for its warming effects. Fruits were tolerated only in the form of spreads, especially made of figs, whose cleaning properties were praised, along with those of almonds. On top of that, preserves of flowers, fruits and aromatics were recommended on a regular basis. They could be steamed in distilled wine with theriac, mithridate, Armenian bole, among other ingredients, before their preparation as an opiate.

The recommended treatment thus aimed to systematically cover all aspects of therapy, including fumigation, bloodletting, medication, workout and diet. All these parameters were supported by Fernel's explanation of pestilence and its multiple ways of affecting bodies. They also involved a series of determined ingredients and preparations, which I shall now examine.

Cardiac Drugs and Antidotes

In his *Consilia* and *Therapeutices*, Fernel adopted the traditional Galenic pharmacopoeia of simple and compound drugs.[71] The simple drugs were individual ingredients which featured first, second or third faculties. They were used either alone or mixed with other simples into compound drugs. Mostly based on plants, simples also included mineral and animal substances. The classification of simples had existed since Antiquity, with Pliny's *Naturalis historia*, Dioscorides' *Materia medica*,

[70] Ivi, p. 139: "Mane vacuato corpore partes omnes motibus clementibus exerce, quibus si sudor blandus superveniat, linteis mollibus tergendus est. Ab hoc ubi corpus deferbuerit, cibum sumes coctu facilem, sed paulo parciorem solito".

[71] Ausécache 2006.

Galen's and Avicenna's pharmacological works. They were developed in pharmacopoeias and antidotaries published in the Latin West, by physicians ranging from Matthaeus Platearius' *Circa instans* to Valerius Cordus' *Dispensatorium*. In the fifth book of his *Therapeutices*, Fernel classified simples for internal use according to their effects on the body part and the four humors, and according to the organ to be treated.[72]

In his therapy of sweating fever, Fernel gave priority to drugs that healed the main organ targeted by pestilence and poison: the heart. Dedicated "cardiac" (*cardiaca*) drugs expelled this type of affections and fortified the body's spirits thanks to the properties of their total substance. The pharmacological theory of cardiac remedies had been diffused by Avicenna in his treatise *De viribus cordis* [*On the Forces of the Heart*], which was appended to the Renaissance edition of the *Canon* and at times translated as *De medicinis cordialibus* [*On Cordial Remedies*].[73] Fernel also expounded on this category in his *Therapeutices*.[74] The listed simple and compound cardiac drugs were the basis for the therapeutic protocol of the *Consilia*. They encapsulated the variety of ingredients used in pharmacy, including plants (bugloss, sorrel, tormentil, thistle, scabious, aloes), citrus fruits, spices (saffron, cinnamon, clove), animal products (musk), gems (pearl), clay (*terra sigillata*, Armenian bole), resin (amber) and precious metals (gold).

Across Fernel's therapeutic protocol, lemon and bugloss – both cardiac simples – were the most recurring ingredients for the making of potions, pills, *alexipharmaka* and distillates. Regarding diet, meat had to be marinated in the juice of citrus fruits and seasoned with cardiac plants. In addition to cardiac simples, other "occult" drugs with a strong third faculty played a part in Fernel's *Consilia*. Among them, common purgative plants, such as cassia and rhubarb, entered in the composition of the purging potion at the beginning of therapy. The fragrant plants used for fumigation aimed to purify the corrupted air and to protect, by inhalation, the patient's lungs and heart from pestilence thanks to the powers of their total substance (rosemary, sage, aloes, cloves, styrax) and their hot qualities (juniper, laurel, marjoram, thyme).[75]

72 Fernel 1567, pp. 441-481.

73 On Avicenna's *De viribus cordis*, see McVaugh 2009; Weill & Parot 2010.

74 Fernel 1567, p. 468: "Quod affectus pauci in cor invadere posse credantur, cardiacae facultates praecipuae sunt, noxia omnia malignaque depellere, et cordi robur conferre".

75 On drugs with hot properties, see Fernel 1567, pp. 464-465.

Most of the ingredients mentioned in Fernel's *Consilia* comprised local plants that were geographically and financially accessible in Western Europe, such as bugloss, sorrel, tormentil, thistle, scabious and borage. But the therapy also included luxury and often exotic plants (aloes, santal, roses), fruits (dates, almonds, lemons, oranges), spices (cinnamon, saffron, turmeric, clove), resin (myrrh), game (thrushes, partridges, hares, roebucks), precious stones and metals (pearl–based *diamargariton*, gold), which were all mentioned in Greek and Arabic pharmacology. The most expensive simples in Fernel's *consilia* on the sweating sickness entered in the composition of a particular *alexipharmakon*, which much seemed like an augmented version of theriac and mithridate. Both included in his *Therapeutices*, theriac and mithridate were the main compound drugs for treating plague and pestilence in early medicine.[76]

Outside of the existing remedies for pestilential diseases, physicians might also create new compound remedies by combining simples. Some new properties might emerge from the "fermentation" (*fermentatio*) of the initial ingredients after the mixture of their elements.[77] However, physicians were not able to anticipate these effects, especially their third faculties, which required experience through multiple trials and observation – an idea which had been put forward in Avicenna's *De viribus cordis*.[78] For Fernel, the art of composing drugs also justified the prominent place of the learned physician for making diagnosis and prescription. While physicians had the knowledge and experience for prescribing medication and setting the composition of drugs, apothecaries were only required to diligently select and prepare these ingredients.[79]

76 On theriac in the late Middle Ages, see Nockels 2007. In his *Therapeutices*, Fernel proposed an affordable version of theriac based on four ingredients (*diatesseron*), in addition to a traditional recipe based on more than fifty ingredients, including snake, opium and balsam: Fernel 1567, pp. 538-539.

77 Ivi, p. 424: "At vero cum multorum in compositione iamdiu facta est confusio, atque ea quam iuniores fermentationem appellant, mutua actione omnium quaedam coitio atque concursio evaserit, pristinae singulorum vires non amplius integrae manent, neque illas potest facultas ulla discretrix in nobis seiungere: sed pereuntibus et extinctis singulorum viribus, novae prorsus emergunt, ex illarum tamen concursione profectae".

78 McVaugh 2009.

79 Fernel 1567, p. 424-425: "Simplicium autem cognitio, collectio, delectus, expurgatio, conservatio, praeparatio, correctio et miscendi industria, seorsum ad pharmacopaeos referuntur ac pertinent: quorum tamen imprimis et medicum gnarum peritumque esse oportet, siquidem apud artis ministros auctoritatem dignitatemque suam retinere ac tueri velit [...]".

Preparation: Potions, Pills and Distillates

Fernel's *Consilia* proposed remedies in various medicinal forms, from potions to pills to distilled wines and electuaries. In his *Therapeutices*, he explained that the texture and preparation of drugs could stimulate or soften their initial powers.[80] For instance, moisturizing and emolliating properties were present only in fresh simples containing a lot of humor, such as fruits and seeds. Their powers were more efficient in a broth, juice or oil. Desiccant and cleansing properties could be found in dry ingredients. Moreover, liquid drugs like potions had purging and penetrating properties, while solid drugs like pills were mostly attracting and fortifying.

Among internal remedies, solid drugs could be made in the form of powder, pastille, electuary (*electuarium*), bolus, eclegma, confection (*confectio*) and preserve (*conditum*). Liquid drugs could be prepared in the form of decoction, infusion, wine, broth, emulsion, juice and syrup. These different forms were often associated to the mode of extracting powers, mostly, by means of infusion, "elixation" and distillation. Infusion, for its slow and moderate cooking, better conveyed the powers without dissipating those of "thin" matter, so that the plant juice coming from infusion could keep all of its faculties. "Elixation" (boiling) attracted the powers of "thick" matter inside the broth, while dissipating the powers of "thin" matter.

Distillation had an important role in the extraction of drug powers in Renaissance pharmacy. In *De abditis rerum causis*, Fernel suggested that such a technical "art" (*ars*) was key in the therapy of the total substance. As Sylvain Matton's has shown, some alchemical processes, which had been explored by Ficino and Augurello, were discussed in the end of this treatise.[81] Fernel's considerations prompted numerous commentaries in alchemical literature from the late sixteenth to the mid–seventeenth centuries, for instance by the German physicians Andreas Libavius and Michael Maier. The bone of contention was about his support of the alchemical practice of chrysopoeia, that is the transmutation of metals. Fernel, indeed, suggested the possibility of distilling some "quintessence."

[80] Ivi, pp. 422 and 424-425.

[81] Fernel 2005, pp. 710-721. On Fernel's alchemical considerations in *De abditis rerum causis*, see Matton 2002.

Called "philosopher's stone", "elixir of the Arabs" and "seed" for generating gold, this quintessence was allegedly extracted from gold and mercury. However, Fernel immediately mocked this alchemical process as a vain quest for money and gold.

Beyond his ambiguous position regarding chrysopoeia, Fernel supported the use of alchemy for medicinal purposes along the lines of Renaissance physicians. He described alchemical practice as the "separation" of three substances from plants and animals.[82] Such "water", "oil" and "ash" were extracted from their raw material, which consisted in the four elements. Although these alchemical products were mixed compounds, Fernel considered them as having a purer nature due the strong presence of their total substance and weakness of their secondary qualities. He particularly insisted on the beneficial effects of distilled vegetable oil, whose flavor and odor evidenced a powerful total substance.[83] This oil corresponded to the plant's "radical moisture" (*humor primigenium*), which the Latin–Arabic medical and alchemical literature described as a fatty humor present in all living beings, with strong restorative powers.[84] The technical operations of distillation were further described in a dedicated chapter of Fernel's *Therapeutices*.[85]

Fernel also acknowledged the possibility of distilling minerals, especially gums, resins and metals, but stated that it required intensive work only to obtain a very small amount of precious oil.[86] Nonetheless, gold leaves and pearl powder, as longstanding ingredients of ancient *materia medica*, were part of his prescription of the distilled *alexipharmakon* for the sweating sickness in the *Consilia*.[87] Some "philosopher's egg" (*ovum*

[82] Fernel 2005, pp. 710–713.

[83] Ivi, pp. 712-713: "Efficaciorem in oleo [...]: illud siquidem et odore, et sapore totius substantiam referens, propria sedes dignoscitur insiti spiritus et caloris, in quibus proprietas tota subsistit foveturque".

[84] Fernel 1567, p. 425: "[...] stirpis cuiusque materiam humorem continere [...] primigenium, in quo praecipua vis inest [...]. Oleum vero humidi est primigenii portio aeria, atque ut illius odorem saporemque, ita et vires plurimum refert [...]". On radical moisture in Renaissance medicine and alchemy, see Pomata 2018; Crisciani 2005.

[85] Fernel 1567, pp. 425-426.

[86] Fernel 1567, p. 426: "Hac ratione Halchymistae ex lachrymis, resinis, atque etiam metallis per humectationem oleum extrahunt purius et odoratius [...]. Sed ad id longo opus est tempore et maxima diligentia, atque in moderando attemperandoque igni dexteritate summa: et ad postremum pro impensa opera ex pulveris libra dimidia vix puri et sinceri olei uncia elici potest".

[87] Fernel 1585, pp. 139-140.

Philosophicum) was also recommended in the treatise, as a well–known medication, though without any details.

Along with texture and odor, the pleasant taste of drugs was another important feature which ensured the smooth administration of the treatment.[88] In his *consilia* about the sweating sickness, Fernel proposed some potions and electuaries whose composition included sweet and fragrant ingredients, such as sugar, fruits and cinnamon. Besides bringing a nice taste to remedies, these products had the convenient effect of fortifying the patient's "spirits". This was particularly useful for treating pestilence, which provoked the exhaustion of the body by attacking its physiological spirits. While reviving the patient during purgation and antidotal treatment, the sweetness of remedies offered an appealing and comforting dimension to the whole therapeutic experience.

Conclusion

In applying his theory of the total substance to the explanation of deadly epidemic fevers, Fernel sought to elucidate the unknown, the unpredictable and the imperceptible in his medical philosophy. He did so by covering both theory and practice across the fields of pathology, pharmacology and therapy. Fernel's account of pestilential diseases is particularly interesting in its integration of diverse explanations of contagion, "occult" causation, and astral influence that were proposed by ancient, medieval and Renaissance physicians. His explanation drew on Galen's approach to the total substance and pathology of pestilence, which emphasized the corruption of air and the seeds of plague putrefying the body. However, Fernel deviated from this framework by ascribing the efficient cause of pestilence to some astral configuration, and its contagion to "occult" factors beyond dietetics. His conception merged late medieval and Renaissance interpretations on the astral causation of plague with the Avicennian interpretation of the total substance related to the specific form of bodies. According to Fernel, the total substance was the embodied instantiation of the celestial form of living beings, which was infected by the poisonous seeds of pestilence. This explanation was integrated into a Platonic framework, which highlighted the influence of the heavens on living beings, following the philosophy of Ficino.

[88] Fernel 1567, p. 422: "Iucunditas porro quoad licet medicamentis comparanda, modo ut illorum vim et facultatem non tollat: tristia enim et horrenda nec sumuntur facile, nec continentur, sed ventriculum evertunt, corpus conturbant, ac plerumque animi defectione vires exolvunt. [...] Haec enim odoris iucunditate non modo oblectant, sed et corroborant, et corporis spiritus vehementer reficiunt, animumque exhilarant".

Beyond his attempt to explain the unexplainable, Fernel provided a practical counterpart to his philosophical understanding of pestilence as an "occult" disease of the total substance. His conception of treatment continued the Avicennian medicine by putting forward the crucial role of experience in composing drugs and preparing therapy. Such an emphasis on practice was expressed by Fernel's constant insistence on repeated trials and resort to observation. Technical skills were involved in the making of powerful drugs based on various vegetal, animal and mineral components. Alchemical distillation, in particular, allowed to extract the total substance of these ingredients, which partly remained implanted in their body after death. In explaining the hidden powers and making of drugs, Fernel also suggested to take into account the influence of the stars regarding each step of their preparation. Such an appeal for astral influence, alchemy and experience–based therapy did not only recapitulate the previous conceptions that were expounded by Galenic physicians. Diffused in the widely read *Universa Medicina*, Fernel's account shaped alternative interpretations emerging in the early modern period, most notably, in Paracelsian medicine.

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Fabrizio Baldassarri[*]

ELEMENTS OF DESCARTES' MEDICAL *SCIENTIA*: BOOKS, MEDICAL SCHOOLS, AND COLLABORATIONS

Introduction

In 1643 Johannes van Beverwijck (1594-1647) contacted René Descartes (1596-1650) to ask a Latin version of his demonstration of the circulation of blood to contribute to *Epistolicae quaestiones* (1644). Van Beverwijck was a physician in Dordrecht and since 1635 a professor of medicine and anatomy at the Illustrious School therein. In 1611 he matriculated at Leiden University, where he studied medicine, and in 1616 he matriculated at Padua, where he graduated under the supervision of Hieronimus Fabricius ab Aquapendente (1533-1619). Besides its role in publishing the dispute between Descartes and Plemp on the circulation of blood, this exchange is emblematic of Descartes' connection with Dutch scholars and physicians who were trained at the Medical Faculty at Leiden University, and in some other cases at the Medical School of Padua. In developing his medical knowledge immersed in the Dutch enthusiasm for the anatomy lessons, a connection with the medical faculties of Leiden and Padua mediated by his *collaborations* surfaces as a meaningful element in shaping his medical science.[1]

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[1] "Les centres scientifiques très vivants que [Descartes] fréquentait en Hollande ont été très profitables au développement de sa pensés," in Serrurier 1951, p. 88. See also, Verbeek & Bos 2013, pp. 161-177.

DOI 10.48255/M.9788891320186.11

While Descartes lived close to Leiden and was in direct contact with physicians and scholars therein, where he also matriculated at his second arrival in Holland, a connection with Padua appears more latent, if not missing at all. He never corresponded with anyone from Padua, nor visited the city of Veneto.[2] Yet, the medical knowledge developing there influenced Descartes' medical reflections. As such, this is a mere intellectual proximity. At the time, Dutch physicians generally visited or, in some cases, even completed their medical training at Padua University before returning to Holland.[3] Padua thus influenced the institution of the Leiden University, as I briefly detail in section 2 of this chapter, before focusing on Descartes' contacts, collaborations and intellectual exchanges with a few fellow physicians. The Dutch medical context, and its link to Padua, therefore played a crucial role in Descartes' studies of medicine.

In this chapter, I explore Descartes' anatomical experimentation, collaborative efforts, and acquaintance with medical books. In section 3 of this chapter, I pinpoint the dissections and observations that unveil Descartes' collaborations with his fellow physicians that had completed their training at Padua. Furthermore, several references to the medical texts reveal Descartes' uses of books as a point of departure for his experimentation. In section 4 of this chapter, I identify these books written by scholars associated with the University of Padua and connect them to Descartes' anatomical studies. Both the underlying connection to the Padua Faculty of Medicine and the more evident one to the Leiden physicians play a crucial role in shaping Descartes' medicine and favoured the emergence of medicine as a modern *scientia*.

In conclusion, while rebuking the picture of an isolated and loner Descartes, or a philosopher of a stove-heated room, I show that both direct collaborations and a connection with universities were important in shaping his medical *scientia*. Indeed, Descartes performed several physiological observations and dissections and was receptive of the medical knowledge of his contemporaries, ultimately highlighting how much Descartes is a case study to understand the context and intersection of the medical traditions of the Medical Faculty of Padua and the Leiden University in the development of a modern medicine.

[2] Although Descartes had planned a Grand Tour in Italy in which he should have visited Venice, Loreto, and Rome, Theo Verbeek has recently shown that Descartes more likely remained in Valtellina, Verbeek (unpublished). I thank Professor Theo Verbeek for having shared with me his knowledge.

[3] On the School of Medicine at Padua, see Cima 2015.

The University of Padua and the Dutch

Since the sixteenth century, the Faculty of Medicine of the University of Padua was one of the most prestigious seats for the study of medicine in Europe.[4] This was due in part to the astounding achievements of the University: it was the centre of the emergence of modern science, but also one of the most important centres for innovations in medicine.[5] In this period, a new culture of anatomical observation and physiological quantification developed at Padua, and was disseminated beyond Italy.[6] For example, this knowledge significantly shaped the work of both Andreas Vesalius (1514-1564) and William Harvey (1578-1657), who had completed their training at Padua.

In the sixteenth and seventeenth centuries, the University of Padua was the climax of *peregrinatio medica*.[7] In addition to its intellectual prestige, its religious tolerance motivated the enrolment of many foreign students at Padua. These latter were subdivided into *nationes* or confraternities with their own statutes and, in some cases, their own libraries.[8]

Students from the recently founded Dutch Provinces fell under the *nationes Germanicae* and cooperated in the intellectual life of Padua. The presence of Dutch scholars at Padua should not be overlooked, especially in the light of the role of medical science in Holland in the sixteenth and seventeenth centuries. Regrettably, while the importance of transalpine students has been generally noted, and the links between English students and Padua have been recently fleshed out,[9] more work needs to be done on the connections between Dutch students and the Medical Faculty of Padua. It is well known that Leiden's professors of medicine and several other scholars had spent some time at Padua be-

[4] Cf. Siraisi 2001; Grendler 2004. See Zampieri in this volume.

[5] Bylebyl 1979, pp. 335-370.

[6] Maclean 2009, pp. 59-86.

[7] Klestinec 2010, pp. 193-220.

[8] Rosetti & Bonfiglio Dosio 1986.

[9] Marrone et al. 2016.

fore 1625,[10] but Dutch scholars attended courses at Padua after this date as well.[11]

This connection is revealed by several features. Since the second half of the sixteenth century, scholars reacted positively to the attention paid to anatomy from a natural philosophy perspective. Developing out of Vesalius' work, anatomy acquired more central status. At Padua the pursuit of this inquiry into anatomy marked a transformation of the discipline, as may be noted in Girolamo Capivanni's (1523-1589) *De methodo anatomica* (1593). This intensity of the philosophical interest in anatomical lessons made them a major component of medical science.

Anatomy was an expertise which Dutch scholars brought back fruitfully to Holland from Padua. This is mainly testified to by the Leiden anatomical theatre, one of the venues where anatomy is taught. Since 1597, Leiden University has had an anatomical theatre, erected according to Pieter Pauw's (1564-1617) specifications. His model was the anatomical theatre of Padua, where Pauw had spent a three-month period, becoming acquainted with Hieronimus Fabricius ab Aquapendente, one of Vesalius' successors.[12]

Furthermore, the creation of the Leiden *hortus botanicus* was influenced by the structure of the botanic garden at Padua, therefore confirming the parallel between Renaissance anatomy and Renaissance botany.[13] Gerardus Bontius (or Geraert Bondt, 1536-1599), who promoted the founding of the Leiden botanical garden, graduated from Padua. Evidence of this influence is to be found in the work of Bernardus Paludanus (or Berent ten Broecke, 1550-1633), a medical student at Padua, who was asked—but refused—to become prefect of the Leiden garden.[14] Nonetheless, Paludanus brought back to Leiden the plans he had made of the Padua garden. These were used in planning the layout of the Leiden garden and then printed together with Pauw's *Hortus publicus Academiae Ludguno-Batavae* (1601). Moreover, the teaching of botany relied on the practical demonstration of the medicinal plants developed at Padua. Another connection testifying to the presence of the Paduan

[10] Cf. Prögler 2013, p. 184.

[11] See Rossetti 1967, vol. 1.3.

[12] Cook 2007, p. 113. On anatomical theaters, see Klestinec in this volume.

[13] Findlen 2006. See Egmond in this volume.

[14] Cappelletti & Ubrizsy Savoia 2011, pp. 79-92.

experience in Leiden arose in 1633, when the third edition of Adrianus Spigelius' (or Adriaan van den Spiegel,[15] 1578-1625) *Isagoges in rem herbariam libri duo* included an appendix listing the plants collected in the Leiden garden, a text elaborated by Adolphus Vorstius (1597-1663) and entitled *Catalogorum plantarum horti academici, cui accessit index plantarum indigenarum, quae prope Lugdunum in Batavia nascuntur* (1633).

These are only some minor hints of the connection between medical science in the Dutch Republics and the Faculty of Medicine of Padua University, a connection that requires further analysis and research. If anything, the presence of Dutch physicians at Padua relevantly defines a link that goes beyond simply the medical discipline, and concerns the method of observation and experimentation applied to medicine (anatomy and botany, as we have seen), as well as the mechanization and mathematization of nature and living bodies. All these issues significantly shaped early modern medicine and *scientia*.

'It is not a crime to be interested in anatomy': Descartes' dissections

It is known that Descartes began his studies of anatomy and medicine in 1629, after his second arrival in the Dutch Provinces.[16] No evidence suggests he received any significant training in medicine at La Flèche,[17] nor that he worked on medicine since his sojourn in Paris in 1625. His medical interest constitutes a section of the study of physics he began in Holland, and which led to the ambitious, but unfinished and unpublished treatise *De la Lumière* or *Le Monde*.[18] Chapter 18 of this treatise is a physiological section, posthumously and independently published,

[15] Spigelius was a professor of medicine at the University of Padua, see Lindeboom 1978.

[16] See Descartes to Mersenne, 18 December 1629, in AT I, p. 102: "je veux commencer à estudier l'anatomie."

[17] In his biographical reconstruction in the *Discours de la Méthode*, Descartes briefly refers to medicine amongst other sciences, but it seems unlikely he attended these studies at La Flèche or later in Paris. Cf. *Discours de la Méthode*, I, AT VI, 6. See Lindeboom 1979, p. 5.

[18] Descartes to Mersenne, November or December 1632, AT I, 263; CSMK, p. 40: "My discussion of man in *mon Monde* will be a little fuller than I had intended…"

called *L'Homme* (1633, but published in 1662 and 1664).[19] This is an innovative study of the human body.[20]

Growing attention is being devoted to this text, in which Descartes undertakes to explain the functions of man by means of several experiments, as he clearly states to Mersenne in 1632: "I am now dissecting the heads of various animals, so that I can explain what imagination, memory, etc., consists in."[21] More attention to the experimentation that underpins this text is required. In February 1639, Descartes states that he had trained himself in anatomy, taking into consideration both "what Vesalius and the others write about anatomy, [and] many details unmentioned by them, which I have observed myself while dissecting various animals. I have spent much time on dissection during the last eleven years…"[22]

Immersed in the observation and dissection of animal limbs, Descartes' life in the Dutch Provinces was attentive to the science of medicine,[23] a branch of his natural philosophy. Practicing anatomical dissections developed as a crucial means of his physiology. For this pursuit, Descartes would have needed the help of trained physicians, and his ability to meet people he could learn from succeeded, as in the case of Isaac Beeckman (1588-1637),[24] even in the case of the fruitful collaborations he established with physicians.

Anatomy and collaborations

In *La Description du corps humain* (1647-8, but published posthumously in 1664), Descartes claims that: "the ignorance of anatomy and mechanics has contributed to"[25] the ignorance of physiology and medicine. This acknowledgment of anatomy is important, especially in the light of the philosophical questions raised concerning the relationship

[19] See Clerselier, *Preface*, AT XI, xii.

[20] See Antoine-Mahut & Gaukroger 2016.

[21] Descartes to Mersenne, November or December 1632, AT I, 263; CSMK III, 40.

[22] Descartes to Mersenne 20 February 1639, AT II, 525; CSMK III, 134.

[23] Lindeboom 1979; Carter 1983; Des Chene 1996; Aucante 2006.

[24] Van Berkel 2000, pp. 46-60; Arthur 2007, pp. 1-28; van Berkel 2013.

[25] *La Description du corps humain*, I, art. 2, AT XI, 224.

between anatomical knowledge and intellectual method in Descartes' philosophy.[26] Several passages in praise of anatomy may be also found at the beginning of *L'Homme* and in the Fifth part of the *Discours de la Méthode*.[27]

Additionally, Descartes described himself as a devoted, self-taught anatomist, as he dissected bodies to fill out his medical science. In November 1639, he writes to Mersenne that when he was living in Amsterdam in the early 1630s he went to a butcher to watch the slaughtering of cattle, and took home the parts he intended to dissect.[28] Some years later, Vopiscus Fortunatus Plemp (1601-1671) reports that, when Descartes lived in Amsterdam, he was "ignored by everyone, […] like a man who did not read, nor own many books […], he dissected animals, [and one may find him] just as Hippocrates found Democritus outside Abdera."[29]

Medical knowledge is a special case of Descartes' contraposition between a knowledge grounded in books and a science grounded in deduction and experimentation, that is, on Descartes' methodology.[30] In April 1630, he writes to Mersenne that he is studying "chemistry and anatomy simultaneously; every day I learn something that I cannot find in any book."[31] Anatomical observations thus disclose a privileged perspective for the achievement of medical science.

He began working on anatomy in the Dutch Provinces, at the end of 1629, as he wrote to Mersenne.[32] Vincent Aucante has endorsed Geneviève Rodis-Lewis' position that Descartes may not have pursued a medical degree at Poitier, but that his medical interest presumably originates in Holland.[33] The study of medicine appears as a Dutch enterprise in Descartes' biography. This especially favoured his anatomical observations.

[26] See Roux 2000, pp. 211-273; Meschini 2013; Andrault 2016, pp. 175-192.

[27] See *L'Homme*, AT XI, 124. *Discours de la Méthode*, V, AT VI, 47-ss.

[28] Descartes to Mersenne, 13 November 1639, AT II, 621.

[29] Plempius, 21 December 1652, in Plempius 1654, p. 374. Quoted in French in Cohen 1956, p. 468. In Plemp to Descartes, 15 September 1637, AT I, 401. It should be noted that Plemp urged Descartes and Cartesians to be Democritean.

[30] Cf. *Discours de la Méthode*, I, AT VI, 9-10. On the relationship between experience and deduction, see Baldassarri 2017, pp. 115-133.

[31] Descartes to Mersenne, 15 April 1630, AT I, 137; CSMK III, 21.

[32] Descartes to Mersenne, 18 December 1629, AT I, 102.

[33] Aucante 2006, pp. 70-71.

Upon his arrival in Holland, Descartes first matriculated at the University of Franeker in 1629, and then at Leiden University on the 27th of June 1630. Especially this second has played a crucial role in shaping Descartes' medical knowledge. Descartes occasionally attended public dissections in Leiden, presumably at the anatomical theatre of the University,[34] and then dissected animals and made personal observations in Amsterdam. It is likely he put the skills he acquired in Leiden into practice. Yet, since dissecting is a difficult pursuit for a not educated in it, he presumably benefited from the help of some scholars or physicians such as Henricus Reneri (1593-1639), Johann Elichmann (ca1601-1639), and Plemp.

Let us put Reneri aside for the moment, as he possessed no degree in medicine, despite having studied medicine at Leiden, and focus first on Elichmann and Plemp. Descartes is presumably referring to Plemp and Elichmann in his 1630 letter to Mersenne when he stresses his work on chemistry and anatomy as the beginning of his medical interest. Indeed, both of them fill the topic of Cartesian early study.

The Silesian Elichmann was renowned for his medical expertise, and especially for his ability in making chemical therapeutics, such as some pills made out of the healing mineral springs waters of Spa. Regrettably, it is not known where he took his medical degree. Descartes introduced Elichmann to Reneri in 1631, who writes to De Wilhem that he expects Elichmann's chemical knowledge to "complete, or in any case illustrate, that more general philosophy of Mr. de Cartes."[35] Chemical experiments would reveal the corpuscular structure of nature,[36] but also ease medical knowledge, at least on its practical side. Descartes jotted down a few therapeutics in which he uses chemical bodies, now collected in a manuscript published posthumously by Alexandre Foucher de Careil and entitled *Remedia et vires medicamentorum* (1859-1860). For example, Descartes writes about mercury and antimony using the traditional notation and detailing their effects on the body.[37] Additionally, both in *L'Homme* and in the medical section of the *Discours*, Descartes refers to the chymi-

[34] Descartes to Mersenne, 1 April 1640, AT III, 49.

[35] Reneri to De Wilhem, 10 September 1631(a), Amsterdam, UBL, BPL 293A.

[36] Descartes was aware of this, as he wrote to Villebressieu in the Summer of 1631; cf. Descartes to Villebressieu, Summer 1631, AT I, 213-217.

[37] *Remedia et vires medicamentorum*, AT XI, 642. Cf. Baldassarri 2016a, pp. 243-252.

cal operation of distillation.[38] Still, no clear reference to Elichmann surfaces.

In 1630, Elichmann introduced Descartes to Plemp. The latter had studied humanities at Leuven, then matriculated at Leiden in the Medical Faculty. In 1623, Plemp studied in Padua under Spigelius, and graduated from Bologna in 1624. After the publication of the *Discours de la Méthode*, Descartes and Plemp had a fascinating epistolary exchange on the circulation of the blood, the recent discovery made by Harvey which Descartes publicly endorsed and Plemp opposed—this is the one published later by Van Beverwijck. In their correspondence, Descartes and Plemp supported their respective theses by means of several dissections and vivisections.

This correspondence is not just a controversy, but reveals a familiarity between Descartes and Plemp. Supposedly, in their epistolary exchange they were restoring the coordinates of a collaboration that occurred before 1637 and was grounded in anatomical dissection and the reading of medical books. Plemp refers to Galen as "our Galen,"[39] mentioning specific books by Galen as well as several passages from them. In his answer, Descartes comments on these passages by means of his method, but also sets out an anatomical table and describes vivisecting a hare and an eel to bolster his explanation.[40]

This is proof of Descartes' anatomical observations and evidence of a common experience with dissections that binds them. Presumably, they had dissected animals before 1637 in order to investigate the structure of the body, and observed the heart in particular.

The *Excerpta anatomica* (1859-60), a biomedical manuscript published by Foucher de Careil, contains evidence of several anatomical observations at this period. In the first note of this text, Descartes describes an experiment on the heart of a calf.[41] He examines the structure of the ventricles, the disposition of parts in the heart, whether there is a connection between the aorta and the *vena arteriosa* (today known as the

[38] *L'Homme*, AT XI, 121, 125. *Discours de la Méthode*, V, AT VI, 53.

[39] Plemp to Descartes, January 1638, AT I, 497.

[40] Descartes to Plemp, 15 February 1638, AT I, 526-7. Descartes to Plemp, 23 March 1638, AT II, 66.

[41] *Excerpta anatomica*, AT XI, 549: "In corde vitulino a me dissecto". Since these notes have been found in Leibniz's manuscripts, which are now edited, I refer to Leibniz's work as well, see LSSB, vol. 8/2, p. 545. Regrettably, it is difficult to date this note.

pulmonary artery), and the valves in the vena cava, aorta, and *vena arteriosa*.[42] In this note, he also rejects the presence of pores in the intraventicular septal, likely following Realdus Columbus (1516-1559), as Vincent Aucante suggests[43]. It is to be noted that Columbus' *De re anatomica* (1559) is a major reference in Plemp's *Fundamentis medicinae* (1638) as he discusses the absence of pores in the septum. Although this note is undated, it is likely that Descartes made this observation in the early 1630s, at the time of his anatomical collaboration with Plemp. Therefore, it is likely Descartes collaborated with Plemp in performing these observations on the heart, and it is likely Plemp provided Descartes with Columbus' book.

Many other notes in the *Excerpta anatomica* report Descartes' dissections of calves.[44] He does not focus on the heart alone, but also on the oesophagus, stomach, intestines and other viscera. He also dissected sheep, codfish [*in pisce* cabeliau], and hake [*Schocfisch*].[45] These notes report observations that parallel Descartes' epistolary exchange with Plemp.

The latter was not the only anatomist Descartes knew in these years. Presumably, Plemp introduced Descartes to Adolphus Vorstius, whom Plemp had possibly met in Padua and then in Leiden.

Vorstius had been professor of medicine and botany at Leiden University since 1624. He had studied in Leiden, where he defended a *Disputatio de Motu* under Gilbertus Jacchaeus (ca. 1578-1628), and in 1622 he received a diploma in Medicine at Padua, where he studied under Spigelius. His father, Aelius Everhardus Vorstius (1565-1624) had also studied in Padua, working with Girolamo Mercuriales (1530-1606) and Fabricius. Although the only letter between Descartes and Vorstius is dated 1643, the latter was a good friend of Descartes even before the 1640s.[46] In 1639, Descartes shared with Mersenne the *Catalogus plantarum horti academiae Lugduno-Batavae* composed by Vorstius in 1633.[47] As he spoke of the catalogue, Descartes appeared in close relationship with the fellows at the Hortus botanicus in Leiden. For example, he claimed to know which herbs were planted at the botanic garden, which grew and which did not. Furthermore, in his exchange with Mersenne on the sensitive herb, Descartes frequently refers to somebody else whom was interested in receiving the seed or ready to cultivate it, and so on. If this man is not Vorstius himself, it is likely he is someone in Leiden, where people failed to cultivate the sensitive herb.[48]

[42] *Excerpta anatomica*, AT XI, 549-552; LSSB, 545-48.

[43] AUCANTE 2000, p. 175, n.94, pp. 249-251.

[44] *Excerpta anatomica*, AT XI, 553: "In vituli juniors…"; 554: "juvenis vituli"; 556: "in tertio vitulo".

[45] IBIDEM, 617-618.

[46] Descartes to Vorstius, 19 June 1643, AT III, 689.

[47] Descartes to Mersenne, 25 December 1639, AT III, 633.

Regrettably, there is no evidence of any collaboration between Vorstius and Descartes, but they probably shared knowledge, and perhaps even anatomical observations. The 1643 letter early mentioned appears as a letter for public use, and not just a private exchange, insofar as Vorstius could have suggested he defended Descartes against his critics and required a full statement of his doctrine of animal spirits to achieve his goal.

In these years, Descartes also worked with Reneri, with whom he had a sincere friendship.[49] Reneri had studied philosophy at Leuven and theology at the Collège Wallon at Leiden. In 1625, he enrolled as a student of medicine at Leiden University. Despite his interest in this discipline, Reneri did not take a degree in medicine. From 1634 he held the chair of philosophy at the Illustrious School of Utrecht, which in 1636 became a University. When Reneri supported a dispute at Utrecht University, he asked Descartes to provide him with comments on the subject in question. Reneri and Descartes also engaged in experiments and observations on plants and animals during the winter of 1637/1638. Regrettably, little is known about their anatomical studies.

However, in some notes collected in the *Excerpta anatomica* and dated November 1637, Descartes describes a few anatomical experiences with calf foetuses using the first person plural.[50] These notes focus on the disposition of organs during generation, a topic missing from *L'Homme*. Since Descartes pursued observations with Reneri at this time, the 'we' used in this text presumably refers to him and Reneri.

Perhaps an earlier note, of uncertain date, may testify to a collaboration between Descartes and Reneri. Not because of a direct reference to the Dutchman, but because in this note Descartes provides important anatomical details. Here, he observes the brains of sheep, examining

[48] Descartes to Mersenne, 15 September 1640, AT III, 176.

[49] See BUNING 2013; IDEM 2015, pp. 65-78.

[50] *Excerpta anatomica*, AT XI, 583-587; LSSB 568-571.

their nervous system, shedding light on the pineal gland, and also describing the *Infundibulum*. This latter is a funnel-shaped membrane disposed behind the pituitary gland, in which "the spirits pass from the pituitary gland to the pineal gland."[51] A reference to the infundibulum is in *La Description du corps humain*, while no reference surfaces in the early *L'Homme*.[52] Additionally, this is the first time Descartes names the pineal gland correctly, given that in both *L'Homme* and *La Description du corps humain* he omitted its anatomical name. The acknowledgement of these parts of the body might testify to collaboration with a fellow physician. Since these notes seem to be later than 1633, the period of his work on *L'Homme* and his early collaboration with Plemp, it is possible that Descartes collaborated with Reneri while dissecting the brains of sheep.

Moreover, some other notes on nutrition, plants, and generation were perhaps jotted down during a collaboration between Descartes and Reneri during the winter of 1637/38, although no clear references arise.[53] In 1638, Reneri introduced Descartes to Henricus Regius (or Hendrik de Roy, 1598-1679), who in 1637 had become professor of medicine at Utrecht University. If Descartes' encounter to Reneri has been fundamental, his relationship with Regius has been no less important.

Regius matriculated in the Faculty of Law at Franeker University in 1616; in 1618 he matriculated in medicine at Leiden University. In his tour of France and Italy, Regius received the degree of doctor in medicine at Padua University on 29 March 1623. The committee for Regius' final evaluation was especially drawn up Santorio Santorio (1561-1636) and Spigelius. Since 1638, Regius and Descartes had been sharing medical knowledge and had met several times.[54] It is reasonable to assume that Regius helped Descartes with anatomical dissections and observations, as they display a familiarity in discussing physiological and anatomical subjects in the discussions concerning Regius' academic disputes.

An interesting case arising in their correspondence is the one concerning the lacteal vessels, the chylous system discovered by the Paduan

[51] *Excerpta anatomica*, XI, 583. Cf. Bos 2017, pp. 95-111.

[52] *La Description du corps humain*, AT XI, 270. See Meschini 2016, pp. 49-62.

[53] This is more than plausible for the note on Accretion and nutrition, *Excerpta anatomica*, AT XI, 596-8.

[54] See Bos 2002; Strazzoni 2018a; Idem 2018b.

professor of Medicine Gaspare Aselli (1581-1625).[55] In the late 1630s, in Leiden University scholars debated the role, and observed the functioning of these vessels, thanks to the presence of physicians such as Franz de le Boë (or Sylvius, 1614-1672), a lecturer of anatomy, and later a professor of medicine in Leiden, Franziscus van der Schagen (c.1615-1673), who graduated at Leiden University in 1639 on a medical disputation *De epilepsia*, and Johannes De Waal (or Walaeus, 1604-1649), among others. Descartes knew all of them and certainly attended Sylvius's public demonstration on the circulation of the blood.[56] In May 1640, Descartes claims to Regius that "[c]oncerning the lacteal vessels […] I have not seen them yet. However, I am acquainted with two young physicians [*Medicinae Doctores*] (named Sylvius and Schagen) who do not look unlearned and who affirmed to have observed [these vessels] many times."[57] Descartes then adds a brief explanation of the lymphatic system, and finally invites Regius to perform a vivisection and observe the vessels. At the end of July, it is clear Descartes had performed vivisections on dogs, as he writes to Mersenne.[58] Likely, these observations show a contact between Descartes and Walaeus, as suggested by Francesco Trevisani. Indirect confirmation of their acquaintance is in a letter of May 1641 to Regius, where Descartes refers to Walaeus as a pacific man.[59] Although Descartes' knowledge of the lacteal vessels remains precarious, as he did not insert any reference to them in *La Description du corps humain*, nevertheless he was in direct contact with physicians at Leiden University who performed the experimentation with dogs and confirmed Aselli's theory.

Let us return to Regius. In 1646, Regius included a number of Cartesian subjects in *Fundamenta physices*, his elaboration of an entire philosophy with a whole section on medicine. For example, his description of the brain parallels *L'Homme*, a text Descartes claimed Regius had had no licit access to.[60] Since Descartes did not show his text to Regius, they probably discussed some of these topics with a few anatomical details.

[55] Meschini 2015.

[56] Schmaltz 2017, pp. 262-263.

[57] Descartes to Regius, 24 May 1640, AT III, 69 (translation is mine).

[58] Descartes to Mersenne, 30 July 1640, AT III, 140-141.

[59] Descartes to Regius, May 1641, AT III 374. Trevisani 1992, pp. 224-225.

[60] Meschini 1998, p. 66.

In 1647, however, Descartes charged Regius with plagiarizing *L'Homme*.[61] This especially concerns the case of Regius' interpretation of eye muscles related to sight. However, Regius' explanation of these muscles differs from the explanation given in *L'Homme*. According to Descartes, this was because Regius had hastily read and thus misunderstood a smuggled copy of *L'Homme*. This misunderstanding may also have had an oral (and not illegitimate) origin, as it is possible that Descartes had discussed the topic personally with Regius without providing every detail. Indeed, the question of nerves and eyes was the subject of a 1641 dispute Regius sent to Descartes and on which the latter commented.[62]

This case is significant. Presumably, Regius inferred the presence of a valve in the nerves partly from Descartes' physiological framework, without knowing it in detail (either because he had read a copy of *L'Homme* hastily, or because he had discussed the topic with Descartes too rapidly), and partly from a quantitative evaluation belonging to his training with Santorio at the University of Padua. He might have measured the motions of spirits and then inferred that a valve could prevent a large flow of spirits throughout the nerves.[63]

This combination of Paduan medicine and Cartesian, mechanistic physiology sounds fascinating. While Descartes' collaboration with Regius is significant in many philosophical respects,[64] an analysis of their exchanges on medical knowledge relying on anatomical observations is crucial in comprehending Descartes' medical studies. Descartes surrounded himself with learned and expert physicians with whom he could observe and perform dissections. Since he worked with Plemp, Vorstius, and Regius, who had studied or completed their training at Padua University, the knowledge they acquired in the seat of early modern medicine positively boosted Descartes' medical knowledge on its more empirical side. At the same time, he was also in contact with phy-

[61] Descartes to Mersenne, 23 November 1646, AT IV, 566-7. Descartes to Elisabeth, March 1647, AT IV, 626. See Bos 2017; Schmaltz 2016, pp. 71-90; Verbeek 1988, p. 40.

[62] Descartes to Regius, May 1641, AT III, 373-4. Cf. Regius 1641, IIIa, p. 33. See Bos 2002, pp. 223-224. It is to note Regius inserted a reference to Descartes' *La Dioptrique*.

[63] Farina 1975, pp. 363-399; Rothschuh 1968, pp. 39-66.

[64] Pertinent attention to the relationship between Regius and Descartes may be found in Kolesnik-Antoine (Mahut) 2013, pp. 125-145; Wilson 2000, pp. 659-679; Clarke 2010, pp. 187-207; Bellis 2013, pp. 151-184; Alexandrescu 2013, pp. 433-452; Bos 2013, pp. 53-68.

sicians in Leiden, such as Vorstius himself, who performed public observations of the blood circulation or of the lacteal vessels.

Descartes and the books of medicine

When detailing his medical work, Descartes speaks of dissections and observations, but also claims that he reads books. Despite his early letter, Descartes also develops a positive attention to books. In his 1632 letter to Mersenne, after describing his anatomical studies, Descartes adds that "I have seen the book *De Motu Cordis* which you previously spoke to me about…".[65] Some years later, Descartes mentions Vesalius and other authors. Still, Descartes' use of medical books is untraditional and requires an analysis.

Indeed, Descartes never read books to buttress his theories or to seek for an authority, but mainly to substantiate his knowledge, especially in those complex cases in which observation is necessary.[66] Medical books contain experimentation and observations of the body that are useful for Descartes' science.[67] The observations which physicians described in their books allowed him to confirm his own knowledge, as he claims in the *Discours* when he speaks about the circulation of the blood.

Descartes describes his theory of the circulation of the blood by referring to Harvey's *Exercitatio anatomica de motu cordis et sanguinis in animalibus* (1628). This is a significant case, as Descartes claims to have read the book in a later date, after having developed a theory of blood circulation independently. Indeed, their theories differ hugely, as Descartes himself avers.[68] In his work, Descartes acknowledges the primacy of Harvey's *De Motu cordis*, but then goes on to argue against the latter's theory as a way to prove his own.[69] This crucially clarifies Descartes' way of using books: he did not blindly endorse someone else's theory, but examined it in the light of his own *scientia*.[70] In this case, he reads medical

[65] Descartes to Mersenne, November or December 1632, AT I, 263; CSMK III, 40.

[66] Cf. Baldassarri 2016b, pp. 324-342.

[67] *Discours de la Méthode*, VI, AT VI, 63.

[68] See Gilson 1984[5], pp. 51-101; Trevisani 1992; Grene 1993; Idem 2005; Aucante 2006, pp. 187-228.

[69] *La Description du corps humain*, II, artt. 27-8, AT XI, 239-245.

[70] *Discours de la Méthode*, VI, AT VI, 50-51.

books not to borrow arguments or to provide an authority from them, but to make his theory comprehensible to the reader.

His reading of medical books is variously attested. In August 1637, Descartes confirms to Corneliis Van Hogelande (1590-1662), a Dutch physician and chymist, that he has received several books on medicine.[71] Presumably, Reneri also shared the books of his library with Descartes. Amongst his more than 300 books on medical and pharmaceutical subjects, Reneri possessed a copy of Harvey's *De motu cordis* of 1628, which Descartes may have consulted.[72] Several of Reneri's books are from professors at Padua University, such as two copies of Santorio's *De statica medicina*—we ignore which edition—and Santorio's *Methodus vitandorum errorum* (Geneva, 1630); Gabriele Falloppio's (1523-1562) *Opera medica* (Venice, 1606); Girolamo Mercuriale's (1530-1606) *De arte Gymnastica* (Venice, 1573) and *De Decoratione* (Venice, 1601); Fabricius ab Aquapendente's *Tractatus de respiratione & alii* (Padua, 1625) and *Opera chirurgica* (Frankfurt, 1620); Fortunio Liceti's (1577-1657) *De constitutione hominis in utero, de monstruorum natura & causis* (Padua, 1615); Spigelius' *Anatomia* (Frankfurt, 1633) and *Isagoge in rem Herbariam* (Padua, 1606); Realdus Colombus' (1516-1559) and Falloppio's *De re anatomica* (Paris, 1562).

Although we cannot be sure what texts and books Descartes actually read, some of them contain notions he knew for certain, and were probably borrowed from Reneri's library. Let us briefly analyse these books. Besides Columbus, of whom I have discussed earlier, Descartes knew Aquapendente's theory of valves in veins, published in *De Venarum Ostiolis* (1603), and described by Caspar Bauhin (1560-1624) in *Theatrum anatomicum* (1605), which Reneri possessed. On a page of *Excerpta anatomica*, Descartes directly refers to a case described in Bauhin's *Institutiones anatomicae corporis virilis et muliebris historiam exhibentes* (1597), but which is also contained in Bauhin's *Theatrum anatomicum*.[73] It should be noted that, like Harvey, Bauhin studied at Padua under Aquapendente. Even Aquapendente's *De formato foetu* (1604) and *De formatione ovi et pulli* (1621) inspired Descartes.[74] Indeed, he claims

[71] Descartes to Van Hogelande, 30 August 1637, AT I, 394.

[72] Reneri 1639, ff. 6-17.

[73] *Excerpta anatomica*, AT XI, 591. Cf. Bitbol-Hespériès 2017, p. 153.

[74] See, for example, *Primae Cogitationes*, AT XI, 511; 524 on the presence of female testicles; 531 on the role of the urachus in fetus; 532-534. See Aucante 2000.

to have read Aquapendente's work since the early 1630s,[75] when he refers to some observations with eggs and chicks collected in several notes of *Excerpta anatomica*.[76] Indeed, Descartes observed the formation of chicks in eggs, and inferred a timeline for the formation of organs. Another text by Aquapendente Descartes knew was *De visione, voce, auditu* (1600), as his knowledge of ears and eyes was rather precise as testified by a short note in *Excerpta anatomica* in which Descartes describes the ears of sheep,[77] or from his description of the eye in *La Dioptrique*.[78]

Another case develops from a letter he wrote to Vorstius in 1643. Three reasons make this letter important. (1.) The letter shows that Vorstius had sent a copy of Giuseppe deli Aromatari's *Disputatio de rabie contagiosa* (1625), which includes an epistle on the generation of plants from seeds, the *Epistola de generatione plantarum ex seminibus*. (2.) The letter is a synopsis of his medical system as if aiming to introduce it in Leiden. (3.) Descartes refers to "Spiritus dicuntur a Medicis Vitales."[79] A reference to vital spirits is important in Descartes, who only refers to these spirits in two notes collected in two biomedical manuscripts. In the *Primae Cogitationes circa generationem animalium* (posthumously, 1701), when he describes animal generation, Descartes calls subtle parts "vital spirits [*spiritus vitales*]," but also stresses calling "blood or vital humour [*humorem vitalem*]" the coarser parts [*crassiores*].[80] He writes again of vital spirits in a note of 1631 collected in the *Excerpta anatomica* and entitled "Partes Similares et Excrementa et Morbi" [Similar Parts, Excrements and Diseases].[81] Both notes contain clear references to Galen's physiology and to Hippocrates' study of diseases, and the second note brings together reflections whose sources are renowned physicians such as Rembertus Dodonaeus (or Rembert Dodoens, 1517-1585), Petrus Forestus (or Pieter van Foreest, 1521-1597), Ioannes Schenckius (or Jo-

[75] Descartes to Mersenne, 2 November 1646, AT IV, 555: "et pour la formation des poulets dans l'œuf, il y a plus de 15 ans que j'ai lu ce que Fabricius ab Aquapendente en a écrit…".

[76] *Excerpta anatomica*, AT XI, 614-617; 619-621.

[77] *Excerpta anatomica*, AT XI, 581-2.

[78] Gabriel Alban-Zapata has recently proved that Descartes' study of the eye borrowed from Kepler; see Alban-Zapata 2016, p. 163.

[79] Descartes to Vorstius, 19 June 1643, AT III, 688.

[80] *Primae Cogitationes circa generationem animalium*, AT XI, 505-6.

[81] *Excerpta anatomica*, AT XI, 601.

hannes Schenck von Grafenberg, 1530-1599), Nicoleas Tulp (1593-1674) and Bauhin, amongst others.[82] It should be noted that Vorstius published a short text on disease in 1634, *Liber de divino in morbis, quod Hippocrates in prognosticis medicum observare jussit* (1634).[83] They probably shared books and knowledge on this subject. With respect to these books, Reneri possessed Schenckius' *Observationes medicae* (Franckfurt, 1600) and *Partitiones medicinales*; Forestus' *Observationes*; Dodoens' *Herbarius* (1608); and Bauhin's.

In the *Excerpta anatomica*, Descartes refers the texts of these authors, but some direct mentions surface in his correspondence as well. For example, in a 1640 letter Descartes writes from Leiden to Mersenne, he refers to a curious history in Forestus' *Observationum et curationum medicinalium de febribus* (1591), about the foetal connection with the body of the mother.[84] The remedy collected in the *Excerpta anatomica*, and then those collected in the manuscript entitled *Remedia et vires medicamentorum*, are generally borrowed from the text of Schenckius Reneri possessed and Descartes likely consulted.[85]

In sum, the reading of medical books was important in Descartes' studies of anatomy and physiology. While several Ancient authors appear, such as Galen, Hippocrates, and Aristotle, amongst others,[86] in this section I have detailed some books by authors who had studied or were associated with Padua University. In his correspondence, Descartes mentions Vesalius' *De humani corporis fabrica* (1543), Harvey's *De motu cordis*,[87] Forestus and others; in his notes he refers to Aquapendente, Columbus, and Bauhin, and especially Schenckius in the elaboration of a therapeutic. In all these cases, Descartes uses books he could exploit in order to establish medical experimentation; at the same time, he maintains his philosophy of reading, as he uses *primary* books, those whose subjects necessarily ground early-modern medicine. In this sense, through Descartes' readings, we have an evidence of what early modern thinkers believed to be fundamental books for medical knowledge.

[82] Bitbol-Hespériès 2017, p. 153.

[83] See "Vorstius, Adolphus" in Lindeboom 1984, pp. 2088-2089.

[84] Descartes to Mersenne, 30 July 1640, AT III, 121.

[85] Bitbol-Hespériès 2017, pp. 154-161.

[86] Cf. Aucante 2006, pp. 68-69.

[87] Ongaro et al. 2012.

Conclusions: Descartes, Leiden, Padua and a modern medicine

In this chapter I have explored the sources operating in the constitution of Descartes' medical knowledge. During his second stay in the Dutch Provinces, Descartes enrolled at Leiden University where he likely started studying medicine: he observed, dissected, anatomized, but also read medical books while he was working at his mechanical physiology. In doing so, he especially benefitted from the collaboration of learned physicians, Reneri, Plemp, Vorstius, and Regius, amongst others. Most of them had completed their training at Padua, and this is a significant detail about Descartes' ability to collaborate with experts in a particular field, but also reveals how much the Medical Faculty of Padua indirectly determined Descartes' medical knowledge. Moreover, after the publication of the *Discours*, in a period in which he was filling his medicine with new knowledge, Descartes significantly settled down close to Leiden. In this period he attended public lectures, vivisections and dissections on the blood circulation or on the lymphatic system performed by Leiden physicians, such as Sylvius or Walaeus. Even this connection to Leiden is crucial, insofar as Descartes considered mandatory to have a direct contact with experts in dissections and anatomical observations in order to fulfil his medical science.

In sections 3 and 4, I have explored the sources Descartes used to improve his medical knowledge. In his medical observations, Descartes availed himself of the collaboration and expertise of his fellow physicians. Generally, he collaborated with physicians who had been trained in Padua. Presumably, they taught Descartes how to dissect (and even vivisect) animals, but they also provided him with medical books and texts. He possibly worked with Plemp in the dissections of the heart, before the more famous discussion concerning the circulation of blood, with Reneri on the dissections of the brain and vegetal bodies, with Vorstius on dissections of the nervous system, and with Regius as well, although no clear report for these collaborations ever surfaces. Then, I have also investigated several medical texts Descartes knew and referred, or borrowed material from. What is interesting to note is that both experimentation and books concur in the acquisition of medical knowledge even in Descartes' *scientia* grounded on the evidence of the reason, despite his famous claim to acquire knowledge only a priori.

Moreover, while examining the collaborations, experimentation, and books he consulted in order to achieve his medical science, Descartes

appears in the intersection between the Medical School of Padua, where Dutch scholars generally achieved their *peregrinatio medica*, and Leiden University, close by where Descartes lived, and which emerged as an important seat for medical knowledge in the seventeenth century. In this sense, despite the flaws of his project, Descartes' medicine clearly exemplifies the emergence of medicine as a modern *scientia* in Europe.

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Luca Tonetti*

TESTING DRUGS IN GIORGIO BAGLIVI'S DISSERTATION ON VESICANTS

Introduction

Early-modern pharmacopoeias included a particular class of preparations called *phoenigmi* or *rubifacients*, that were able to cause redness, inflammation, and produce blisters upon application, serving as a cupping-glass to attract the humours inside the body and foster their discharge.[1] Vesicants fall into this category. Despite the numerous side effects and adverse reactions – mainly, severe and lasting tissue injuries, but also mucosal irritation and urinary urgency, or hematuria – their use for medical purposes has a long history dating back to Antiquity. Numerous substances carry out such a blistering and stimulant action – e.g. euphorbium, hellebore, ranunculus or insect poisons, like the one derived from ants or beetles (particularly, cantharides, the so-called "Spanish flies") – to different extents, depending on the formulation, the administration methods (e.g. by ointment, liniment, powder, or tincture), and the part of the body involved.[2] Such use was widespread in early modern medicine (and even beyond), al-

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[1] See Castelli 1657, s.v. "Phoenigmus": "[...] Quippe ejusmodi medicamenta omnia calefaciunt, desiccant, & cucurbitulae ritu humorem altius insidentem attrahunt".

[2] For a list of substances, see the entry "vésicatoire" in the *Encyclopédie*, by Henri Fouquet: also available online by ARTFL Encyclopédie Project (Autumn 2017 Edition), Robert Morrissey and Glenn Roe (eds), https://artflsrv03.uchicago.edu/philologic4/encyclopedie1117/navigate/17/503/?byte=1871294&byte=1871307&byte=1871310. Accessed 29 November 2019. This entry is classified as "Med. thérapeutique & Matiere médicale."

DOI 10.48255/M.9788891320186.12

though both the mechanism of action and the healing effect were much debated.[3]

In the 16th and 17th century, a wide literature about the preparation and application of vesicants appeared, aiming to maximize therapeutic effects or even warn physicians about the severe risks for patients.[4] At the end of the 16th century, in Italy, Paduan physicians – Hercules of Saxony (1551-1607), Alessandro Massaria (1510-1598), Girolamo Fabrici d'Acquapendente (1537-1619), Emilio Campolongo (1550-1604), Albertino Bottoni (d. 1596) – intensely discussed the use of vesicants (and theriac) as a treatment for a pestilential fever occurred in Pesaro in 1591. A dispute raised when, in the same year, Saxony published the *Disputatio de phœnigmorum, quæ vulgo vesicantia appelluntur, & de theriacæ usu in febribus pestilentibus* (On the use of phenigmi, the so-called vesicants, and theriac in pestilential fevers), supporting the use of vesicants. Massaria replied against this view in *De abusu medicamentorum vesicantium et theriacae in febribus pestilentibus disputatio* (On the abuse of vesicants and theriac in pestilential fevers). In 1593, Saxony again addressed this issue in a more thorough work, *De Phoenigmis libri tres* (On phenigmi), to which Massaria's reply followed accordingly (*De abusu medicamentorum vesicantium disputatio secunda apologetica ad librum Herculis Saxoniae De phoenigmis* (Second dissertation about the abuse of vesicants against Hercules of Saxony's book On phenigmi).[5] This is just an example of a long-standing debate about pros and cons of this remedy, particularly about one of its main active ingredients – the powder of cantharides – whose toxicity was already known and reported at that time.

A vigorous debate in Italy followed also throughout the 17th century. In his main work *Il Barbiere* (The Barber), for instance, the surgeon Tiberio Malfi (17th c.) gave a thorough description of how to apply vesicants, providing a visual (and unique) representation of the body which

[3] Such use is strictly connected to the Hippocratic distinction revulsion/derivation. See Marganne 1980.

[4] Research on vesicants dramatically changed at the beginning of 19th century as a result of the discovery, in 1810, by Pierre-Jean Robiquet (1780-1840), of the chemical agent responsible for the blistering action of cantharides, and so called "cantharidin." See Robiquet 1810, and Warolin 1999.

[5] See also *Raccolta di scritture mediche appartenenti alla controversia de' vescicatorj*, appresso Francesco Pitteri, Venezia 1749.

shows the parts that could be treated (see fig. 12.1).[6] Detailed instructions for drug preparation and administration are fully provided. A learned apothecary, Giuseppe Donzelli (1596-1670) – who considered Malfi "peritissimo d'applicare i Vessicatorij" (very expert in administering vesicants) – addressed the same issue in the *Teatro farmaceutico, dogmatico e spagirico* (Pharmaceutical, Dogmatic and Spagyric Theatre), published for the first time in 1667, abounding in recipes for preparing medications from an iatrochemical perspective.[7] Once listed six different formulae of vesicants, he introduces his strong objections and concerns about them, based on the authority of numerous physicians – Alessandro Massaria, Gerardo Columba (16th c.), Orazio Guarguanti (1554-1611), and particularly Jan Baptist van Helmont (1579-1644). A long quotation from Van Helmont's *Febrium doctrina inaudita* (New Teaching on Fevers) – which deems vesicants always harmful to humans – became a common argument against the medical use of this treatment.

Giorgio Baglivi (1668-1707) claimed the contrary. At the end of the 17th century he conceived that this issue was not properly examined. Appeared in 1696 within the *De praxi medica*, *De usu et abusu vesicantium* (On the use and misuse of vesicants) was the result of numerous experiments carried out in the early 1690s in Bologna, Padua, and Rome. These issues were originally addressed in a preliminary work, in 1694, for the fourth volume of Jean-Jacques Manget's *Bibliotheca Medico-Practica* (but printed in 1698). Baglivi revised it after the publication of Lorenzo Bellini's *De contractione naturali et villo contractili* (1695) (On natural contraction and contractile villus), whose last chapter on the action of stimuli provided him with a mechanistic hypothesis able to explain the stimulating action of vesicants. Surprisingly enough, Baglivi inserted this new version as a distinct essay in his work on methodology (*De praxi medica*), thus highlighting the importance of testing drugs for medical practice.

In this chapter, I aim to explore what purpose experimentation plays in Baglivi's methodology. First of all, I will provide a short overview of Baglivi's reform of medical practice. Second, I will outline the history, structure, and main scope of the *De usu et abusu vesicantium*. Then, I

[6] On Malfi, his cooperation with Marco Aurelio Severino, and the authorship of his book, see Conforti 2007, pp. 67-70.

[7] See Donzelli 1681, pp. 720-725 (I use the 1681 edition, with additions by Donzelli's son, Tommaso). On Donzelli, see Messina 1992; Conforti 2007, pp. 70-72.

will describe Baglivi's experiments on vesicants, drawing finally some considerations about the role of experimentation in Baglivi's medicine.

Reforming medical practice at the end of 17th century

Giorgio Baglivi published in 1696 a treatise, the *De praxi medica*, in which he advocated a reform of medical practice according to a Hippocratic and Baconian methodology.[8] Just like Bacon did in the first part of *Novum Organum*, Baglivi identifies six "idola" or impediments to any progress in medicine:

1. The derision of Ancient physicians (book 1, chapter 4: *derisio veterum medicorum*);
2. The false "idols" or false opinions of physicians (bk. 1, ch. 5: *falsa medicorum idola, sive opiniones falso praeconceptae*);
3. A false kind of analogies or faulty similitudes (bk. 1, ch. 6: *falsum genus analogiarum, sive falsae similitudines*);
4. The preposterous reading of books (bk. 1, ch. 7: *praepostera librorum lectio*);
5. The preposterous interpretations of books, and the proliferation of medical "systems" (bk. 1, ch. 8: *praepostera librorum interpretatio, efficiendorumque systematum cacoëthes*);
6. The neglect of the aphoristic style (bk. 1, ch. 9: *intermissum studium tractandi de morbis aphoristice*)

This classification suggests that the decline in clinical skills is essentially due to the neglect of direct observations and bedside experiences.

However, there is a major question just around the corner. This emphasis on the importance of observation is strictly related to the age-old rationalism-empiricism conflict that had existed for many generations of physicians since Ancient medicine. Baglivi tries to meet apparently irreconcilable demands: the spread of systems in medicine on one side, the quest for a more experienced clinical practice on the other. Thus, in Book Two, he outlines a new method that would be able to ensure an empirical basis for medicine. While avoiding the mistakes and fallacies of empiricism, he proves that the aphorisms of the Hippocratic tradition — and broadly speaking each clinical principle — can be inferred directly from experience. The main purpose of this method is the construction of a "natural history of disease" through a 4-step process: the physician should first collect data by direct bedside observations (*acquisitio*), without any hypothesis or theoretical constraints. Second, these data must be organized (*dispositio*); third, they need to be elaborated (*maturatio ac digestio*), so that, fourth, practical principles can be derived (*abstractio praeceptorum*) by means of non-deductive and eliminative inferences.[9]

Baglivi's method seems to imply a very traditional conception of natural history, in which the physician as a *medicus historiographus* passively records what he observes in nature. This attitude is, moreover, compatible with a prudential view of medicine, which avoids any active intervention on the disease, in order not to affect its natural course: physicians should rely only on the healing power of nature, i.e. by "expectation" (*medicina expectans*).[10] This interpretation results from Baglivi's closeness to some of the core principles of Hippocratism, such as that of "crisis." Remedies should be prescribed in accordance with the natural course of disease, and only if strictly required. For example, evacuants administered at the wrong time (e.g. during the crudity of the body) may harm the patient, making the symptoms worse. In fact, Baglivi says, "since Nature therefore never moves crude matter in the beginning of diseases, or while it is yet blended with good juices, doubtless such an attempt is very unbecoming in art, the interpreter and minister of nature."[11] Caution is recommended since clinical diagnosis, especially in the absence of pathognomonic signs. During medical examination, physicians should first examine the patient in order to detect the occasional and antecedent causes of the disease, without administering any drugs,

[8] On Baglivi's life and works, see: Salomon 1889; Scalzi 1889a. 1889b; Grmek 1954; Idem 1991. On Baglivi and medicine in Rome, see Conforti & De Renzi 2009. On Baglivi's Hippocratism, see Müller 1991. See also: Lonie 1981. Baglivi's methodology is examined in Dell'Anna 1990; Vidal 1990; Idem 2000; and French 2003. See also Andrault 2018; and Tonetti 2018; Idem 2019. *De praxi medica* (Baglivi 1696) will be hereafter abbreviated as PM. English translations are from Baglivi 1704.

[9] I describe Baglivi's 'Baconian' method in Tonetti 2019.

[10] On *medicina expectans* in Baglivi, see Di Trocchio 2000.

[11] PM II, 12, §4, p. 255: "si igitur natura nunquam movet in principio morborum materiem crudam tunc, & cum bonis succis confusam, multo minus ars eiusdem interpres & ministra hoc tentare debebit".

"for fear an unseasonable prescription should perplex the ordinary period of the disease, and sink the constancy of the signs."[12] Remedies may be prescribed only once the exact "species" of disease has been identified.

Two overall aspects should be considered. First of all, in Baglivi's medicine every morbid state is supposed to have an internal order that should be detected.[13] Just like plants or any other natural body, diseases develop, get worse, and resolve according to specific natural laws. Careless decisions could irreversibly compromise the natural course of the disease, by exacerbating symptoms or triggering disease mutations in more dangerous forms. Secondly, physician should immediately classify the "species" of the diseases involved and, particularly, recognise which kind of them, acute or chronic, he deals with. Acute and chronic diseases depend on the fluid/solid distinction: the first ones mainly affect body fluids and, if not appropriately treated, become fatal or incurable. The second ones, instead, depend on solids or on not-yet-concocted fluids. These differences imply diverse clinical treatments. "In acute distempers," Baglivi says, "a great part of the cure depends on the physician's patient waiting and acting with judgment and sagacity; and tho' such diseases come frequently to a spontaneous solution, either by chance, or through the favour of nature, yet physicians are not guilty of greater errors in any part of their profession, than in the cure of acute cases."[14] In the last chapter of *De praxi medica*, he maintains that especially with acute diseases physicians realise, just like Hippocrates, that "Nature is the best curer of diseases."[15] Hippocratic clinical practice suggested minimising the administration of remedies, leaving the morbid conditions to the efforts of nature. By supporting expectation in medicine, Baglivi challenged the malpractice of those physicians that "either forgetting or contemning such precepts, not only fatigue the patient with repeated forms of remedies during the whole period of the febrile accen-

[12] PM II, 8, §1, p. 200: "ne per illorum usum forsan incommodum, ordinaria morbi periodus, signorumque constantia perturbetur".

[13] See Bertoloni Meli 2001.

[14] PM II, 1, §1, pp. 153-154: "In acutis cunctatio, & sagax medici in agendo judicium magnam vim habent ad sanationem; & quamvis saepissime sponte sua solvantur nunc casu, nunc natura favente, nullibi tamen graviores committunt errores Medici, quam in acutorum curationibus […]".

[15] Ivi II, 12, §6, p. 258: "naturas esse morborum […] medicatrices".

sion, but turn the disease, that of itself is favourable and mild, into a chronical and mortal illness."[16] Only in chronic diseases physicians are required to use specific remedies.[17]

This suggests that a physician should moderate his action, by following the course of disease and the natural processes implied—or, at most, supporting them. However, a more accurate analysis may tell us something different. The claim against interventionism does not necessarily exclude any active role of physician: expectation and experimentation are not opposed to each other. Just like Harvey, who "tortured Nature with experiments, and teased her with anatomical dissections, till he forced her to confess the truth,"[18] physicians should interact with nature, strongly question it, in order to grasp the properties of diseases and then establish the most effective treatment. The knowledge of nature, through experiments, is a necessary condition for a respectful management of the disease.

Why a dissertation on vesicants?

Discussions on the uses and misuses of vesicants attracted the attention of physicians, and animated debates. However, Baglivi believes that the common way of dealing with this issue is definitely inappropriate.[19] His aim is actually questioning Van Helmont's strong position on the

[16] Ibidem: "talium praeceptorum, aut obliti, aut contemptores, toto febrilis accensionis tempore, non solum assiduis remediorum formulis pene conficiunt aegrotantem, sed morbum natura sua benignum in classem chronicorum, aut lethalium redigunt".

[17] Ivi, II, 11, §5, pp. 246-247: "Natura profecto diuturnitate mali oppressa fere, ac destituta coctionem, depurationemque morbosae materiae absolvere vix poterit, nisi exhibeatur remedium aliquod morbosam illam speciem prompte extinguens; vel roboretur natura per medicamenta spirituoso-restaurantia & amaricantia; quibus, quasi exhilarata, hostem cervicibus suis diu imminentem tandem excutiat".

[18] Ivi, I, 12, §1, p. 100: "[…] tandiu naturam experimentis vexavit, tandiuque sectionibus anatomicis lacessivit, donec tandem ad veritatem fatendam coegerit".

[19] Ivi, *dissertatio II*, §1, p. 67 (the dissertation follows a separate page numbering): "Acriter inter se hactenus contenderunt Practicantes circa usum Vessicantium, & modo in affirmativas, modo in negativas distracti sententias, adinstar oberrantis alicujus Euripi, incerti hinc inde fluctuarunt. Contentio nata potissimum est, vel propter privata odia à diversitate Sectarum, aliisque de causis inter Medicos excitata, ut inter Massariam, & Saxoniam, qui mutuo quodam odio, non elucidandae veritatis causa de phaenigmis scripserunt, inter Helmontistas, & Galenicos hodiernos, & sic deinceps".

matter, that influenced generations of physicians.[20] Baglivi realises that vesicants may instead be useful under certain conditions. Thus, the *De usu et abusu vesicantium* aims to both accurately distinguish the cases in which such an application is permitted and supported, and the cases in which it is not, and to explain how effectively this remedy works. It achieves exactly what is recommended in *De praxi medica* about the "natural history of remedies." In fact, physicians use to determine the correct application of a remedy a posteriori, *ex juvantibus et laedentibus*, that is from the observed response of the disease to a treatment. But the main scope of a therapeutics that is not dependent on pure experience is to detect exactly the action of treatments and explain how and why they work. This task, which is "a very deep point, and lies at the remotest distance from the senses" and needs the collaboration of the entire scientific community, can be pursued only "from chymistry, from the mechanicks, from anatomy, the principles of natural and experimental philosophy &c."[21]

Originally composed in 1695 for the *Bibliotheca medico-practica*, a sort of "encyclopaedia" on medical practice edited by the Swiss physician Jean-Jacques Manget (1652-1742), a revised version of it was provided by Baglivi in *De praxi medica*. These two versions look, however, very different, if compared with each other.

[20] Van Helmont 1642, pp. 115-116: "Auxilia vulgaria examinare statui, antequam febrium naturam determinem. Sunt autem illa scarificationis, hemorrhoidum apertiones, vesicatoria & id genus alia; cunctaque concurrunt in cruoris, virium, & corporis diminutiones. […] *Vesicatoria autem summe semper nocua sunto, & à spiritu nequam Moloz excogitata*".

[21] *PM* II, 11, §11, p. 251: "[…] a Chymicis, Mechanicis, Anatomicis, Philosophiae demum naturalis, Experimentalisque principiis &c."

TABLE 1

1st Version	2nd Version (1696)
Experimentum I	*Lectori*
Experimentum II	Caput I
>> Corollarium	*Nonnulla praeponuntur experimenta*
Experimentum III	*circa effectus Cantharidum*
Experimentum IV	>> Experimentum I
Specimen Practicum. *De Usu, & Abusu*	>> Experimentum II
Vessicantium	>> Experimentum III
>> §I	>> Experimentum IV
>> Observatio I	>> Historia I
>> Observatio II	>> Historia II
>> Observatio III	>> Historia III
>> §§II-XI	Caput II
Sequuntur alia Experimenta	*De Incommodis ab usu Vesicantium*
Experimentum V	>> §§I-IV
>> Corollarium	Caput III
Experimentum VI	*De Commodis ab usu Vesicantium*
Experimentum VII	>> §§I-V
>> Corollarium I	Caput IV
>> Corollarium II	*Vesicantium natura evidenter*
Experimentum VIII	*demonstratur ex mechanica stimulorum*
Experimentum IX	*doctrina*
Observatio X – *De arteria nova*	>> §§I-II
Experimentum XI	
>> Corollarium	
Experimentum XII	
Experimentum XIII	
Experimentum XIV	

Table 1 - *The structure of the two versions of Baglivi's dissertation on vesicants.*

The first one is more an addition to the entry about tarantism, entitled "Tarantati." It seems to be a preliminary study in which Baglivi only arranged a series of experiments provided with *monita* (warnings and annotations), and a *specimen practicum* strictly devoted to the problem of vesicants (see table 1). In this case, his considerations on the action of vesicants are not directly derived from experiments. Conversely, Baglivi

highlights that his view on the issue results from numerous clinical observations, as shown by the "observationes" included in the *specimen*, without any reference to *experimenta*.

The three observations, renamed "historiae" in the 1696 version, show three distinct clinical cases, perhaps the most representatives of a wider series of observations that, however, Baglivi did not report. They were probably collected in 1692 with Antonio Pacchioni at the Hospital of the Consolation in Rome. In all the three cases, the treatment failed because of a late and incorrect use of vesicants, that does not consider duly the patient's medical history, age and temperament, the morbid species, and the air constitution.

In the first case for example, a 22-year-old, frail and bilious man, caught by a venereal disease, is struck by an angina that changed into pleurisy after an accidental exposure to the "north wind." Vesicants were administered only on the thirteenth day, after the Cornachino's powder, with bad results. In fact, from the fourteenth day delirium, epileptic attacks, hand tremor, abundant urine, steatorrhea occurred, until death on the twentieth day. Similarly, in the second case, a 30-year-old blood-bilious man, with excessive indulgence in sex and drinking, felt abdominal spasms: he was lately administered with vesicants, again after the Cornachino's powder, with the same bad responses—emesis, convulsions, breathing difficulty, and finally death after only four days. In both cases, the use of the vesicants was not only tardy but also secondary to other remedies. The effects do not differ if vesicants are applied as a primary remedy: this is what happened in the third case, in a young 8-month pregnant woman that was affected by strong and persistent abdominal pain. After giving birth, the woman consented to the administration of four vesicants, which caused an immediate suppression of *lochia*. However, severe side effects followed: abdominal pain, excessive sweating, irregular breathing and pulse, until the occurrence of smelly yellowish losses and death within eight days.

Thus, Baglivi tried to draw some clinical implications, without however clearly distinguishing *incommoda* and *commoda* in the application of vesicants, just like in the 1696 version. His main concern was not the remedy itself, but the therapeutic indications adopted by the physician, by supposing that therapy should vary according to the patient's nature (medical history, age, temperament), the morbid condition involved, and the environment (constitutions, season, geo-climatic factors). Just like every remedy, no generalisation is permitted, because the morbid species, albeit unique, occurs each time in a different way, depending on the

clinical pictures and the unpredictability of antecedent causes that could trigger the diseased condition.[22] Even the variety of symptoms depends more on the physician's action than on the disease itself.[23]

The structure of the dissertation is, however, deeply revised in the 1696 version (see table 1). Although without substantial changes from the previous version in *Bibliotheca*, Baglivi not only clearly distinguishes pros and cons of the use of vesicants, but he seems also to highlight more vividly the heuristic role of *experimenta*. With the first chapter, *Nonnulla praeponuntur experimenta circa effectus Cantharidum* [Some experiments on the effects of cantharides], he seems to relegate *historiae* to a secondary role. Baglivi may suggest here, rather, a broader concept of observation, which includes also an 'anatomical' practice next to a pure clinical experience. In the letter to the reader Baglivi emphasises the contribution of in-vivo experiments by means of "infusory" surgery, through which the experimenter is able to generate new, repeatable and controlled data. The four *experimenta* previously reported outside the *specimen* (experimenta I-IV) now play a pivotal role in the dissertation. The hypothesis proposed by Baglivi as a possible explanation of the action of vesicants—Bellini's theory of stimulus—is placed in the last chapter. This suggests that only experiments allow physician to infer the applications of vesicants in medicine.

How to test vesicants?

Baglivi performed the four experiments described in the first chapter in May and July 1692, once he arrived in Rome. As shown in table 2, the first two experiments involved infusions of two ounces of tincture of cantharides into the right jugular vein of two dogs.

Infusory surgery developed in 1660s, particularly in England and Germany, within a more general interest in the nature of blood and its

[22] Manget 1698, pp. 638-639: "Unus enim, & idem specie morbus (v.g. pleuritis) in variis aegrotis varia facie, & variis symptomatis stipatus incedit; varietas tamen illa non est propria illius morbi naturae, sed tota manat à varia, eaque aliquando praepostera medendi methodo, qua à variis Medicis morbi illi tractantur (taceo varietatem causarum antecedentium, quae huic diversae morborum faciei, etiam conducunt".

[23] Ivi, p. 639: "hi [morbi] enim constanti facie, & constantibus symptomatis semper processuri essent, si una & eadem medendi methodo, eaque solida, ac opportuna tractarentur."

applications in medicine as a vehicle for the administration of drugs.[24] In Baglivi, infusions may serve as a reference model for experimentation in living beings. Starting with a standard procedure, physicians can manipulate different variables, such as the injection site, the chemical infused, its volume, and so on, and record how the bodily effects depend on them.

In this case, the injection site, the medication infused, and its volume, are the same. However, the two dogs show different results. In fact, while they both show emesis, ptyalism, and thirst, the first dog died after four days, while the second after only four hours. The difference lies in the manipulation of a further variable: in the first case, the dog was administered twelve pounds of water, which were instead forbidden to the second dog. The water intake may have reduced the corrosive power of poison, by delaying death.

TABLE 2

Experimental subjects	Injection site	Injection volume	Results
Dog	Right jugular vein	2 ounces cantharides tincture	• emesis of aqueous substances • the animal immediately falls to the ground • ptyalism • strong thirst • yellow urine • convulsions • death after 4 days
Dog	Right jugular vein	2 ounces cantharides tincture	• emesis of aqueous substances • the animal immediately falls to the ground • ptyalism • strong thirst • death after 4 hours

Table 2 - *1st and 2nd experiment on dogs.*

[24] On this issue, see Marinozzi & Conforti 2005.

These experiments can be compared with those performed by Baglivi in Naples, in Rome and in Padua in the years 1688-1693 (see table 3), which are all described in the *Bibliotheca* and then republished in *De praxi medica* within a third untitled dissertation, *Dissertatio III*. If we vary the volume of the infused substance, reducing it to half an ounce, the effects are the same: chills, vomiting, salivation, convulsions, and rapid death. Even a change in the injection site can affect the results: in the second and third cases, Baglivi infuses two ounces of wine spirit into the crural and the jugular vein, respectively. Only in the latter case, there is an immediate death, with blood clotting in the lungs.

TABLE 3

Experimental subjects	Injection site	Injection volume	Results
DOG	Right jugular vein	half ounce of cantharides tincture	• chills throughout the body • emesis • ptyalism • the animal immediately falls to the ground • convulsions • death within hours
	post-mortem report	Blackish viscera. Heart and blood are black. The parameters of the other organs are normal.	
DOG	Right crural vein	2 ounces spirit of wine	• chills throughout the body • polyuria • no alteration of physiological processes
	post-mortem report	Bodily solids and fluids are normal.	
DOG	Right jugular vein	2 ounces spirit of wine	• immediate death
	post-mortem report	Coagulated blood in the lungs.	
DOG	Right jugular vein	4 ounces cold water	• chills throughout the body • no alteration of physiological processes

Table 3 - *Baglivi's experiments on dogs (1688-1693).*

The last two experiments described in the dissertation are dramatically different, because Baglivi worked on humans, albeit indirectly, by testing cantharides powder on the blood extracted from some patients. He poured eight ounces of blood in two different vials, in one of which the blood was mixed with the powder. The other one served as a control test, no other substances included, except for blood. Baglivi shows that the blood in the first vial coagulates more quickly than blood in normal state.

Conclusion

In order to demonstrate the application of vesicants, Baglivi decided to test them through infusions. Infusory surgery requires specific equipment and procedures, and it is based on own theoretical assumptions (e.g. some theory of matter concerning the nature of blood). The basic procedure—vein opening, infusion, and suture—enabled Baglivi to manipulate a series of variables and to observe the effects on the experimental subjects. From the manipulation of the part of the body involved (jugular or crural vein), the fluids infused (cantharides tincture, spirit of wine or cold water), the quantity of drug taken (ounces), or the form (tincture or powder), diverse effects follow accordingly.

The above-mentioned examples suggest the potential for medicine. Baglivi not only recognises the need to systematize a precise experimental method ("methodus experiundi"), but also urges the scientific community to work in this new direction, by planning infusory experiments and collecting data.[25] These experiments can be easily replicated and enable the physicians to make useful generalizations for clinical practice, by extending what is observed to human beings.[26] But infusion experiments may obviously fail, even though they are really true, as Baglivi admits in the *De anatome, morsu et effectibus tarantulae* commenting

[25] PM, *Dissertatio III*, p. 104: "prout fecit de rebus Anatomicis praeclariss. Mangetus tanta sui gloria in aureo opere suae Bibliothecae Anatomicae &c. Et de rebus practicis necessarium esse testatur Cl. Lanzonus Prof. Ferrariens. Nostrum Amicissimus".

[26] Ivi, p. 103: "Post infusum liquorem si accurate observabimus omniam accidentia, quae Animali accidunt, circa quaslibet vitae functiones, & circa quodlibet viscus, aut partem corporis; facto analogismo talia metuere poterimus in humano corpore ab infuso illo, si aegrotantibus praescribendum foret".

on Francesco Redi's experiences on the properties of "lapis Indica," an exotic remedy that was supposed to extract the poison from the body.[27] Nonetheless, infusions should be preferred to any other tool because they can overcome the limits of anatomical dissections, which may modify the solid/fluid relationship in the body. Conversely, "[…] the experiments we make upon living animals by way of infusion, afford a clear and unfeigned representation of the effects that proceed from thence".[28] This is the reason why, Baglivi says, "of all the enquiries and laborious adventures of anatomists, I reckon none more useful for the illustrating of the aetiology of diseases, and the structure of an animated body, than the infusion of liquors into the veins or viscera of live animals".[29]

Some important conclusions about the nature of experiment in Baglivi's medicine follow. First, experiments on vesicants show some "exploratory" purposes.[30] Baglivi did not perform infusions assuming the possible results, i.e. starting with a theory or an idea of the possible results that he could record. Baglivi rather intended to find empirical regularities, by examining the effects of manipulating variables in the body. Second, as heuristic devices, experiments support the discovery of new remedies. Moreover, they show also a "pedagogical purpose," because, thank to their affinity with nature, they teach the physician to look at things "ex analogia universi" and not "ex analogia hominis". Finally, testing in vivo (e.g. by means of intravenous injections) allows the physician to examine body solids and fluids simultaneously, without altering them.

[27] Cf. *PM*, *Dissertatio I*, p. 47: "In mentem obiter revocanda sunt praecepta domini Boilei in libello *De experimentis, quae non succedunt*, ubi fuse de non succedentibus quamvis veris exprimentis discurrit".

[28] *PM*, *Dissertatio III*, p. 102: "experientiae, quibus utimur in vivis, praecipue per infusoriam, ostendunt effectus inde profectos valde clare, ac sincere".

[29] Ibidem: "inter omnes investigationes, laboresque Anatomicorum, nihil utilius illustrandae morborum aetiologiae, structuraeque animati corporis duco, quam infusoriam liquorum in venas, viscerave Animalium vivorum".

[30] On "exploratory experimentation," see Steinle 1997; Idem 2002; Franklin 2005. Jalobeanu applies this conception of experiment to Bacon (Jalobeanu 2013).

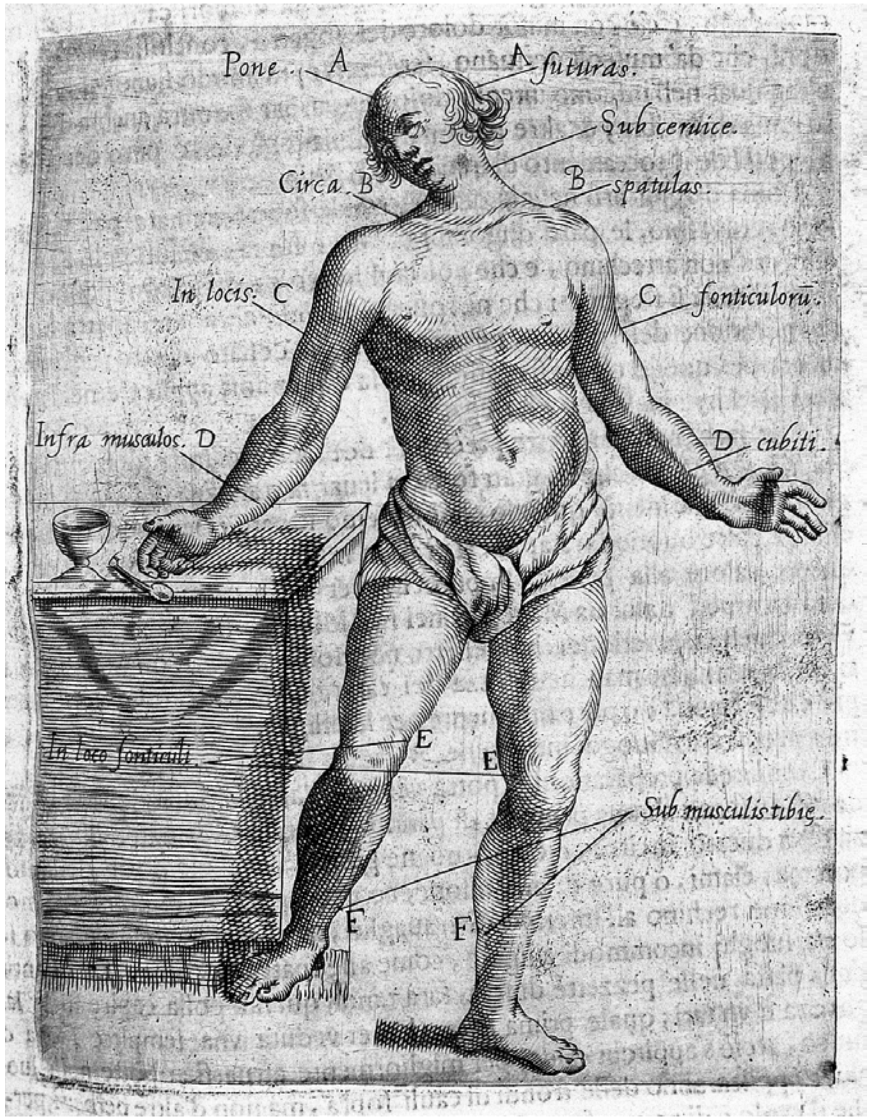

Fig. 12.1. T. Malfi, *Il barbiere...libri tre*, 1626. Credit: Wellcome Collection. (CC BY 4.0)

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TRACING SENGUERD'S FOOTPRINTS: SCIENCES AND TARANTISM AT LEIDEN UNIVERSITY (1667-1715)

Introduction

Wolferd Senguerd (1646-1724) is a little known figure in the field of history of sciences.[1] Professor of Peripatetic Philosophy at the University of Leiden, he is the author of three texts about the tarantula, the wondrous effects of its posion as well as the prodigious and curative properties of some peculiar music. These works are, in order: the early *Philosophical disputation on tarantula* (1667); the *Physical treatise on tarantula* (1668); and finally, the late *Disquisition on tarantula* included at the end of the volume *The marriage of reason and experience* (1715).[2] Analyzing the different reports published on this subject, he intended to elaborate a complete philosophical explanation to illustrate the extraordinary effects caused by the Apulian tarantulas without resorting to the occult qualities. In showing this particular view of tarantism and clarifying the relationship between the philosopher and the sources he used, in this article I aim to explore the discussion that Senguerd held about the so called chromatic attraction which – as shown in his sources – arises in those who are poisoned by the spider.

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[1] The studies of Ruestow 1973; Wiesenfeldt 2002; idem 2003b are exceptions. My Ph.D. thesis is dedicated to the reconstruction of Senguerd's reflection about tarantism and occult qualities. See De Carli 2019.

[2] See Senguerd 1667; idem 1668; idem 1715.

DOI 10.48255/M.9788891320186.13

Wolferd Senguerd on sciences and tarantism

Second son of the Dutch Aristotelian philosopher Arnold Senguerd (1610-1667),[3] Wolferd was born in Utrecht on the 4th of July 1646 (Fig. 13.1). He studied at the Illustrious School of Amsterdam.[4] Here, between 1664 and 1666, under the supervision of his father, Wolferd discussed a series of logical and naturalistic disputations. On the 17th of September 1667 he moved to the University of Leiden, where on the 7th of December of the same year he graduated with a thesis entitled *Philosophical disputation on tarantula*. In the early months of 1668, he published a more expansive version of his *Disputation*, entitled: *Physical treatise on tarantula*. Henry Oldenburg (1618-1677) reviewed the *Treatise* on the *Philosophical Transactions* of the Royal Society.[5]

Senguerd's professional activity was mainly carried out at the University of Leiden. On the 8th of February 1669 he obtained the license to give public lectures and philosophical disputations. On the 20th of February 1675 he was nominated extraordinary professor of Peripatetic Philosophy. On the 16th of January 1676 he obtained the full professorship in the same discipline. After 1675 – the year in which the Physics Theater was established in Leiden with the aid of De Volder's promotion – Senguerd begins to give experimental lectures. In 1705 – due to the retirement of De Volder – he became the director of the Physics Theater. Wolferd took part in the administrative life of the University, working frequently as a rector as well as prefect of the Library from 1701 until his death, on the 26th of January 1724.

Senguerd's intellectual interests are very broad: logic, noetics, natural history, research on wondrous phenomena, medicine, meteorology, pneumatics. His reputation as an Aristotelian philosopher and a pious Calvinist most likely had a significant impact on the Curators' choice to hire him at the University of Leiden, to counterbalance the presence of Cartesian teacher Burchard De Volder (1643-1709). Indeed, his speculation is characterized by a profound eclecticism. In Senguerd's reflection, the key notions of scholastic philosophy are related to elements deriving from different traditions of thought: Cartesianism, Gassendism, Iatro-

[3] On Arnold Senguerd, see Dibon 1954; Van Miert 2009; Wiesenfeldt 2003a.

[4] On the Illustrious School, see Van Miert 2009.

[5] See Oldenburg 1669.

chemistry and Baconism. Within this *novantiqua* and eclectic vision of philosophy, we must place Senguerd's tendency to preserve the vocabulary of the scholastic tradition and to interpret the key notions of Aristotelian philosophy in a different way than their original meaning. This eclectic position is clearly visible in his more mature work. However, it is also prevalent in his early writings on the tarantula.

Senguerd wrote for the first time about tarantism for his degree. To achieve his degree he had to discuss and resolve a philosophical problem.[6] Writing about an extraordinary phenomenon as tarantism, researching its natural causes, discovering its inner mechanisms – in line with the purposes of the early modern university disputation – might be an excellent chance to show one's own dialectical and explanative abilities in interpreting a topic which was so talked about.[7] This seems clear if we consider that the theme was something particularly innovative in the University of Leiden. In fact, as written by Senguerd, at the time of his graduation, the problem was still unexplored in that context.[8]

Senguerd's focus on tarantism is part of his bigger interest in Physics and, more precisely, in the field of the occult qualities. This issue was one of the most discussed topics in seventeenth century, both among the Aristotelians and the Mechanistics.[9] In the terminology of the peripatetic schools of the seventeenth century, the term "occult" – contrary to the term "manifest" – was used to distinguish qualities which were evident to sense and consequently to the mind, and qualities which were structurally hidden (like magnetism, the effects of planets, infections, etc.).

Senguerd's point of view on this theme was significant. In the introduction of the *Disputation*, he claimed that carrying out a study about the occult qualities was a difficult challenge, especially due to the many controversial philosophical opinions concerning the matter. His criti-

[6] See Senguerd 1715, p. 279: "Quum anno praeteriti seculi septimo et sexagesimo, mihi, Doctoratur in Philosophia gradum consequuturo, Academicae leges imponeret necessitatem problema Philosophicum enodandi, eiusque defensionem suscipiendi, prae aliis arrisit argumentum de Tarantula; utpote in hac Universitate hactenus non ventilatum, et quo miscerem utile dulci".

[7] See Fantini 1999, pp. 64-65. On the diffusion of the European medical-scientific debate between 17th and 18th century, see Di Mitri 2006 and idem 2015. For the modern university *disputatio*, see Ventura 2016, p. 147, and corresponding bibliography.

[8] See Senguerd 1715, pp. 279-280.

[9] About this complex debate, see at least Hutchison 1982; Henry 1986; Giudice 2006, pp. 49-55; Parigi 2011, pp. 7-166.

cism, in particular, opposed those who abused this concept due to negligence or inability to offer a more satisfying explanation of natural phenomenona. Although he admitted the existence of the occult qualities,[10] Senguerd thinks that such a concept cannot be used for phenomenons that can be explained in alternative ways.[11] Tarantism is presented as a phenomenon consisting of many aspects explained throughout different, traditional occult qualities. Such occult qualities exist in the poison, the music, the musical instrument and the region.[12] Therefore, the various "occult" aspects of tarantism are clarified using several disciplines of knowing, such as natural history, physics and medicine.

In the frontispiece of the *Physical treatise on tarantula* (Fig. 13.2) there is already some critique about the idea of a relationship between tarantism and the occult qualities. Indeed, the author promises the reader to illustrate with natural reasons the effects of the spider's poison, which until then were ascribed to occult qualities.[13]

This distinction between "occult" and "manifest" was overcome by Senguerd, who thought that the term occult could be used only regarding the human cognition. Historicizing the problem, he affirmed that there are no qualities which are structurally "occult".[14] On the contrary, there are some qualities that – until a given moment – are "hidden" to the human mind and the scholar's duty is to reveal them.[15]

Senguerd's reflections upon the occult qualities should be compared to what he affirmed in the *Natural philosophy*, a sistematic work – firstly published in 1680 – in which many elements are eclectically merged,

[10] One of the sixty *annexa* to the book, in the section *Ex physica generali*, reads: "Dantur occultae qualitates". See SENGUERD 1667, p. C1v.

[11] See IVI, p. A2r.

[12] For example, one of the main sources of Senguerd's *Treatise*, the German physician Daniel Sennert (1572-1637), – referring to the Apulian physician Epifanio Ferdinando – explained tarantism throughout different occult qualities. For a profile of Sennert, see MICHAEL 1997; CLERICUZIO 2000, pp. 9-33; PARIGI 2011, pp. 27-32, 238-242; HIRAI 2011. On Ferdinando, see footnote 34.

[13] See SENGUERD 1668, p. 2: "in quo praeter ejus descriptionem, effectus veneni Tarantulae, qui hactenus fuerunt occultis qualitatibus adscripti, rationibus naturalibus deductuntur, et illustrantur".

[14] IVI, p. 10.

[15] See IVI, p. 11: "Eodem ictus stimulo, manifestam conatus fui proponere Tarantulam, cum Symptomatibus, Effectis, & Curatione, à morsu ejus provenientes; quae pro occultis hactenus fuerunt habita, ut ignota explicata, latentium instar conscripta; à nobis vero ut manifesta proposita".

such as scholastic concepts and ideas derived from different philosophical traditions, like Cartesianism, Gassendism, Experimentalism and Chemical tradition. In the chapter entitled *On qualites*, he claimed that qualities are always generated by the union between motion and matter. This union, in fact, determines all the aspects – like the relations among the matter's parts, their connections, the figuration, etc. – that distinguish the bodies, giving them a special essence. Because of the limits of the human intellect, however, not all the qualities can be perfectly known. As a consequence, if some qualities have been manifested, others remain hidden. Reflecting on this, the ancient authors made a distinction between manifest and occult qualities. For this reason, the occult qualities are hidden only regarding the human perception and intellect; the latter is imperfect, so some qualities, until a given historical moment, remain hidden. Nevertheless, in Senguerd's opinion, this should not be a shelter for ignorance, but an incentive for the scholar, whose mission is to reveal the qualities that were covered by the darkness of ignorance.[16]

In his writings on the tarantula, Senguerd explores the spider's bite, its effects, the power of musictheraphy and the role played by colors. He also examined the animal's characteristics, its habits and its actions (Fig. 13.3). One of the most important points of Senguerd's philosophical work is the reconstruction of the natural history of tarantula and tarantism; in fact, about half of his books on the tarantula are dedicated to this reconstruction. In line with a Baconian idea,[17] Senguerd argues that in natural history it is possible to find information that can be critically analyzed to clarify the occult aspects of tarantism. Therefore, natural history constitutes a solid foundation for the work of clarification of the aspects of tarantism considerated as effects of occult causes. Far from a direct observation of the tarantula and its victims, Senguerd only used the works of physicians, philosophers, naturalists and scholars. This is not something astonishing if we think that – among the high number of publications on tarantism released between seventeenth and eighteenth centuries – only few writers could observe and even directly treat this disease, which was restricted to a particular area of the south of Italy.[18] Senguerd

[16] See SENGUERD 1680, pp. 78-80.

[17] See DASTON-PARK 1998, pp. 220-231: 224.

[18] See BALDWIN 1997, p. 163.

took the information about the anatomy and the habits of the spider from *Historical meditations* (1602-1609) by Philipp Kammermeister (1537-1624). At the same time, the evidence showing that the tarantula's temperament is cold, wet and flegmatic are taken from the observations of Ulisse Aldrovandi (1522-1605), as written in the *History of Serpents and Dragons* (1640).[19] From the Renaissance medical literature, and in particular from the *Commentaries on Dioscorides* (1554) by Pietro Andrea Mattioli (1501-1578), Senguerd took notice of the various effects of tarantula's poison, that could be treated only through music. This information was built upon what was previously said by Plinius (23-79), Claudius Aelianus (c. 165/170-235), Alessandro d'Alessandro (1461-1523), Gerolamo Cardano (1501-1576), Giulio Cesare Scaligero (1484-1558), Niccolò Leoniceno (1428-1524), Thomas Muffet (1553-1604) and Daniel Sennert (1572-1637).[20]

However, thanks to Athanasius Kircher's (1602-1680) *Magnet, or the Magnetic Art* (1654) – certainly the most cited source in his works – Senguerd had a wealth of information concerning tarantism. The Jesuit gave a strong contribution to the seventeenth century's debate about tarantism. He gave information on the spider, on the effects of its bite and its treatment. He also introduced a series of stories of victims of the spider, taken from the works of other Jesuits, namely Giovan Battista Galliberto and Paolo Nicolello, who were respectively rectors of the colleges in Taranto and Lecce in the first decades of the seventeenth century. These accounts increased the number of the stories of the spider's victims which, when the first edition of *Magnet, or the Magnetic Art* was released (1641), was low.

Thanks to the works of his Apulian informants, who were considered reliable and trustworthy – even by Senguerd himself – Kircher could include the story of Roberto Santoro. This nobleman from Taranto was bitten by a tarantula and nearly lost his life because the doctors were not able to identify the reasons of his sickness. Kircher also reported the story of the Spanish man who himself was bitten by two different tarantulas

[19] See Senguerd 1668, p. 18: "Temperamentum Tarantulae, frigidum, humidum, & phlegmaticum tribui deberi, ac multum humoris eam in se continere, probatur ex eo, quod diu sine alimenti assumtione vivat: sic Aldrov. *lib. I de serpent. & drac. cap. de victu serp.* refert, *Tarantulam vivam Roma in intermedio arundinis ad se missam, in ampulla vitrea, dies quinquaginta, sine alimento retinuisse*".

[20] These last three sources are present only in the last two versions. About tarantism in Renaissance literature, see Mina 2001.

– with demonstrative purpose – and died. Moreover, the Jesuit told the story of the girl bitten by tarantula, who could dance only stimulated by the sound of musical instruments like drums and bombards.[21] According to Kircher, these cases confirm the existence of an occult magnetism that is present only in some melodies, and it can attract the spider's poison out of the bitten body, thus curing the victim. Only some particular magnetic music – whose arrangements are transcribed by the Jesuit – has the right "proportion" with the poisons and the human temperament.

The cases of tarantism mentioned in Kircher's books were widely incorporated in the successive debate about the topic, even though many physicians and philosophers rejected the connection with the occult and the mysterious magnetic attraction.[22] Among these, according to Martha Baldwin, it is possible to distinguish a group of authors who refused Kircher's points of view, resorting to a corpuscular explanation of the phenomenon.[23] This is the case, for instance, of the famous English physician Thomas Willis (1621-1675). In his *Essay of the pathology of the brain and nervous stock* (published in latin in 1667, the same year of Senguerd's *Disputation*), he interprets tarantism as a convulsive disease. In his opinion, the toxin does not act on blood, but on the "nervous liquor", thus causing disorder in the animal spirits and, consequently, a spasmodic contraction of muscles and a disorganized movement of limbs, comparable to dance.[24]

Before Willis, another English physician, Walter Charleton (1619-1707), in the chapter *Occult qualities made manifest* of *Physiologia epicuro-gassendo-charletoniana* (1654), tried to give a mechanic explanation of the occult qualities seeing tarantism as a disease that affects the spirits of the brain rather than the spirits of the blood. Taking inspiration from the work of Pierre Gassendi (who was also interested in tarantism

[21] See Kircher 1654, pp. 597-600. For a profile of Kircher, see Findlen 2004. On Kircher's magnetism, see Parigi 2011. See Čermáková 2018, on magnetism in plants.

[22] See Baldwin 1997, p. 180. On the concepts of sympathy and magnetic attraction in the 17th century, see Poma 2009, pp. 219-430.

[23] On seventeenth-century corpuscular theories, see Clericuzio 2000, and corresponding bibliography.

[24] See Willis 1667, pp. 87-90. On Willis' analysis on tarantism, see Arcangeli 2000, pp. 96-97. On the concept of *spiritus* in the 17th century, see Clericuzio 1988.

related to the occult qualities)[25], Charleton made a materialistic explanation of the phenomenon, whose aim was denying the action of magnetic or sympathetic forces between music and poison. If, on one hand, the poison acts through small particles that rapidly penetrate in the body and in the nervous system causing the muscles to move convulsively, on the other hand music contrasts the poison's action, because it transmits movements to the air first and then to the ears. It is the ears that transmit these movements to the brain and its spirits. Then the brain spirits transmit their agitated motion to the poison's particles, which will be later vaporized and expelled through sweating.[26]

Senguerd's opinion is similar to these considerations, since he aims to give a mechanic explanation of the poison's action and focuses on the effects that the poison, a wet and viscous substance, has on the spirits of the nerves. Moreover, in the *Treatise*, Senguerd clarified that the poison's movement, acting on the spirits of the nerves and on the heart, causes agitation, spasm and fever, which are widespread in those who are bitten; in addition, an excessive heat in the heart deteriorates the bile in the nearby vessels. Furthermore, the poison's viscosity obstructs the pores and immobilizes the spirits of the nerves, thus creating an excessive numbness in those bitten. He thus claimed that the dance performed by those who are bitten in Apulia is nothing but the effect of the muscles and nerves' movement caused by the action of the poison upon the spirits of the nerves.[27]

Recalling this series of physiological reactions, it is then possible to explain how the toxin is expelled, without believing that there is an occult quality in music or musical instruments. According to Senguerd's reasoning, when the sound of musical instruments from the air passes through the ears and then to the spirits, it reaches the nerves and the muscles causing the victims to dance. Through this kind of agitation, the blood starts to overheat, the skin pores dilate, the poison rarefies, attenuates and disperses; at the same time the sweat increases and the poison is then expelled through the dilated pores.[28]

[25] See GASSENDI 1649, pp. 355-356.

[26] See CHARLETON 1654, pp. 371-372. On Charleton, see BOOTH 2005.

[27] See SENGUERD 1668, pp. 41-42. On mechanism in early modern medicine and philosophy, see CLERICUZIO 2015, ZAMPIERI 2016 and BERTOLONI MELI 2019.

[28] See SENGUERD 1668, p. 51: "*ratio* autem *cur Tarantiacus saltu sanetur*, in eo consistit, quod per commotionem & vehementem totius corporis agitationem, quae saltu efficitur, sanguis incalescit, pori aperiuntur, venenum illud rarefit, attenuatur & dispergitur; cum autem agitatio vehemens & diuturna adeo sit, ut sudores Tarantati sibi contrahant, hinc sit, ut (sicut *cap. 5* diximus) per sudores venenum ejiciatur, & per cutis poros transeat".

By means of this mechanic system of actions and reactions, the philosopher can give a satisfying explanation of the terrible effects of the tarantula's bite and of its remedies (namely music and dance), without postulating the existence of an occult quality in the poison or music.

All these mechanisms are initially activated by the poison. Basing his reasoning on the natural history of the tarantula, he observes that the spider attacks with its mouth. In this way, the tarantula emits a moist substance. In particular, this poisonous substance consists of a wet liquid, which contains hot particles. Due to its characteristics, this substance is fermentable: when summer heat of Apulia ferments this substance, the hot particles move the spirits of the nerves, stimulating the victim to dance.[29] This solution – based on the combination between corpuscolar theories and the principles of iatrochemistry – is in line with a widespread trend within Dutch physicians and chemists in the second half of the seventeenth century.[30] Moreover, one of the main supporters of this trend is Franciscus de le Boë (Sylvius),[31] Professor of Medicine at Leiden University during the period of Senguerd's graduation.[32]

In the end, the qualities attributed by Senguerd to the poisonous substance are "manifest". These are: hot, moist and viscous. In fact, according to the Aristotelian-Galenic tradition, hot and moist are primary qualities and viscuous is a secondary one. Similarly, the subsequent fermentative and mechanical processes initiated by the poison are "manifest". Since everything is knowable, it is vain to admit the existence of an occult quality in the poison. This is just one of the many aspects that is explained with occult qualities. Senguerd also talked about other extraordinary facts that – according to what Kircher wrote – characterize this disease so common among people in Apulia. The study of Senguerd's reflection on colors allows us to follow the evolution of his thought on tarantism, even after the publication of the *Physical treatise on tarantula*.

[29] See SENGUERD 1667, p. B1v; IDEM 1668, pp. 40-42.

[30] See CLERICUZIO 2000, pp. 187-191. On early modern Dutch culture and medicine, see COOK 2007.

[31] See CLERICUZIO 2003, pp. 232-233. See also DEBUS 2001, pp. 57-64 and RAGLAND 2012.

[32] See MOLHUYSEN 1918, pp. 210*-212*.

Between Kircher and Baglivi: the colors of tarantism

In the popular treatment for tarantism, besides music and dance, colors played a central role. This is evident in the research carried out by Ernesto De Martino. In the second part of *The land of remorse* (1961), he carried out research about the chromatic symbolism, mainly based on the analysis of accounts written by authors in seventeenth and eighteenth centuries, such as Girolamo Marciano[33], Epifanio Ferdinando[34], Giorgio Baglivi[35], Ludovico Valletta[36] and, most importantly, Kircher. De Martino shows how, in a symbolic perspective, tarantulas are constantly associated not only to some melodies, but also to some colors. To exorcise the bitten, it is then necessary to identify both the color of the tarantula and the right music.[37] For example, Kircher stated that for those who are affected by the green color, songs with pleasant lyrics are used, while for those who are sensitive to the red color and to the brightness of weapons, martial melodies with a iambic rhythm are played.[38]

In his analysis of the phenomenon, Senguerd is also interested in the chromatic issue, questioning – already in the *Disputation* – if people bitten by tarantulas are really attracted by certain colors. The answer to this question is based on what is written in the *Magnet, or the Magnetic Art.* Kircher, talking about the variety of behaviors typical of those who suffer from tarantism and considering the information given by the Apulian informants, claims that in the victims, together with an auditive sympathy of the music, there is a visive sympathy – which is not less powerful than the previous – that attracts the eyes towards certain colors. Depending on the type of tarantula that bit them, people may have attrac-

[33] Girolamo Marciano (1571-1628) was a physician and scholar from Leverano (Apulia). He speaks about tarantism in his encyclopedic dissertation, entitled *Description, origin and successes of the province of Otranto*. On Marciano, see Leone 2007.

[34] Epifanio Ferdinando (1569-1638) was an Apulian physician, from Mesagne. In his main work, entitled *One hundred stories* (Venice, 1621), he described the story of a peasant bitten by a tarantula. See Baldwin 1997 and Gentilcore 1999. On Ferdinando's *observationes*, see Pomata 2010, pp. 229-230.

[35] See footnote 51.

[36] Ludovico Valletta was a celestine monk from Lucera (Apulia). The dates of his birth and death are not known. He published a work entitled *The Apulian Phalangium* (Naples, 1706). See Di Mitri 2006, pp. 63-110.

[37] See De Martino 2008^4, p. 171.

[38] See Kircher 1654, pp. 590-591.

tion to colors like green, yellow or red.[39] In order to better clarify this fact, Kircher told the story of a bitten Capuchin friar and the archbishop of Taranto, cardinal Gaetano. The latter was curious about the rumors of the friar's strange dances and wanted to take part into the therapeutic ritual. As the high prelate dressed in purple entered the room, the dancer stopped his dance and changed his view, immediately attracted towards the color of his vest with ridiculous gestures and comical movements, and it seemed that he could have peace only once he took possession of it.[40] The Cardinal then gave the purple vest to the friar, who grabbed it and sensually touched it, bringing it close to the eyes, then to the forehead and then to the chest, as if he wanted to become one with it.[41]

In Kircher's interpretation, because of an occult magnetism, the tarantulas poisons make the victim to feel attracted by their color or by the color they have attraction for. As a result, he concludes that the same humor, which previously caused the tarantula's imagination to be attracted by a certain color, once it is transferred to the human body, it produces the same effects.[42]

Senguerd was in contrast to this point of view; in fact, in the *Disputatio*, he opposed five arguments to Kircher's opinion on the topic. First of all, the evidence used by the Jesuit was extremely weak in the philosopher's point of view. This is the case, for example, of the story of the Capuchin friar who potentially could have been attracted by the figure of the cardinal (considered holy and with healing powers) rather than by the vest he wore. Moreover, the fact that the spider's victims were attracted by colors does not mean that they are affected exclusively by those colors, unless there is other evidence that proves the aversion towards other colors. According to Senguerd, Kircher's support of the occult magnetism was a proof of his ignorance, because it did not give any causal explanation of the phenomenon.[43] He also believed that Kircher

[39] See ivi, p. 588.

[40] See ibidem: "Et ecce vix purpureus Antistes comparuit, cum ecce saltator relicta chorea, in aliam quasi speciem transformatus, ita ridiculis gestibus, adeo insolitis corporis motibus in amicam rapitur purpuram, ut donec ea potiretur, vix contineri posse videretur".

[41] See ivi, p. 589: "Nam illa potius, intime ei abblandiebatur, nunc genis, nunc fronti et pectori applicatam omnibus modis incorporari sibi velle ostendebat".

[42] See ivi, p. 602.

[43] See Senguerd 1667, p. B3r: "*Tertio*, cum Kircherus ejus rei nullam addat causam sed tantum ingorantiam suam fateatur, et dicat ab occulto magnetismo fieri".

was in contradiction with himself, because if it was true that victims are attracted only by the color of the spider that bit them, then it would be useless asking them the color of the tarantula, which is a custom of the musicians from Taranto.[44] Although it is said that they are attracted by a certain color, it would not be that of the tarantula, since – being it the reason of their suffering – it should be avoided.[45]

Senguerd deduced from the natural history of the phenomenon – and in particular from Kircher's work – all the information that was useful to interpret tarantism without resorting to the occult magnetism. As far as the chromatic issue is concerned, he admitted to not being able to give a valid and convincing explanation of a phenomenon wich is non-existent.[46] The empirical existence of the attraction to colors is even denied in the image of tarantism offered by Senguerd, since it cannot be placed is the same system of mechanic actions and reactions – based on the action of poison upon the spirits –, which were used to explain other physiological problems of the spider's victim. The philosopher came to this conclusion only after admitting that Kircher was more reliable for other issues but, in this case, he was a bad interpretor of his own sources.

Senguerd's argument about colors appears expanded in the *Treatise.* In particular, as far as the aversion towards colors is concerned, he found no evidence in the writers he consulted. Studying this particular aspect, he used a mental experiment: if the victims are attracted only by a color and repulse all the others, then they should repulse themselves and other people, who rarely wear clothes of the same color as the spider's; but, as he pointed out, those bitten do not repulse anyone, so this theory is incorrect and vain.[47]

[44] See IBIDEM: "*Quarto*, quia si verum esset Tarantatos tantum appetere colorem Tarantulae, non opus esset quaerere ex Tarantiacis colorem Tarantulae, quod tamen musicos facere ostendit ipse Kircherus *quaest. 2*". Senguerd is referring to KIRCHER 1654, pp. 599-600.

[45] See SENGUERD 1667, p. B3r: "*Quinto*, quia Tarantati potius aversarentur colorem ipsius Tarantulae a qua icti sunt, cum norint Tarantiaci causam illius mali esse Tarantulas, et solemus aversari ab iis, a quibus noxam tulimus".

[46] See IBIDEM: "Quare potius cuncludimus Tarantatos non affici coloribus certis; et propterea huic semptimae quaestioni rationem addere nequimus, cum non possimus reddere cur quid fiat, quod non fit".

[47] See SENGUERD 1668, p. 61: "*Secundo* quia quamvis Tarantati interdum videantur certis delectari et affici coloribus, et circa eos gesticulationes edere, non tamen sequitur eos illis tantum coloribus affici; nisi reliquos ipsos aversari, probetur, quod tamen in nullis auctoribus hoc negotium tractantibus inveni; imo contrarium ejus potius posset astrui, si enim Tarantiaci reliquos colores aversarentur, se ipsos et reliquos homines raro sint induti, ejus coloris vestibus, quem Tarantula prae se ferebat: non tamen (quod sciam) compertum est, Tarantatos plurimos homines aversatos fuisse".

Basically, the same opinions about the colors' aversion are also discussed in the *Disquisition,* which was published in the eighteenth century, in a far different cultural context, with new elements of discussion. Here, in the introduction to his arguments, Senguerd prudently recalled the interpretation widespread among writers – and also present in other parts of the *Disquisition* – according to which the poisoned people are fascinated by special colors while, at the same time, they are scared by others and their mind is filled with unpleasant thoughts[48]. This particular paragraph on colors' aversion found in the *Disquisition* is in contradiction to what Senguerd had previously affirmed in the *Treatise*, that is to say that no author had written about it.

Who is he referring to? If we follow the author's indications and reach paragraph 4 – *On symptoms and effects that follow the transmission of the tarantula's poison* – the aversion to colors is mentioned in a brief text that was not present in the previous versions. In this passage, Senguerd lists all the symptoms of tarantism, such as high fever, loss of appetite, cachexia, pale color on the face, inability to speak, insensitivity, limb tremor, cold sweat, headaches, foot pain, inclination to vomit, damaging of imagination, melancholy, desire for loneliness, penis tension, difficulties in breathing, desire for some particular colors and willingness to run away.[49]

Indeed, Senguerd summarizes, in one list, the different effects caused by different kinds of tarantula (such as the white one, the purple one or that with the shape of a star), that are described in a more recent text

[48] See SENGUERD 1715, pp. 321-322: "Retulimus *supra §. 4 pag. 290* ex Kirchero, Tarantatos non modo ad certam melodiam, saltusque propendere, sed etiam *mirum in modum specialibus affici*, et recreari *coloribus*, iisdem puta *quibus illae gaudent Tarantulae*, quibus ipsis vulnus est inflictum, ac venenum communicatum, dum ab aliis abhorrent, et injucundis cogitationibus corripiuntur. Assertum hoc cum grano salis accipiendum, et accuratius examen meretur. Qui de Tarantula scripsere Multi asserunt in genere, Tarantatos nonnullis coloribus delectari, ab aliis vero abhorrere, nihil speciale de iis definiendo, nec etiam de colorum cum Tarantula covenientia, aut varietate".

[49] See IVI, p. 289: "Praedominantur, maximque familiaria sunt, febres ardentes, appetitus dejectio, cachexia, tetricus faciei color, pungens ventris dolor, obmutescentia, stupor, membrorum horror, sudor frigidus, capitis dolor, itidem digitorum pedis, quandoque cum inflammatione conjunctus, in vomitum propensio, Phantasiae laesio, Melancholia, solitudinis amor, virgae tensio, respiratio difficilis, nonnullorum colorum prae se aliis dediderium, vel fuga".

published in Rome in 1696 (nearly 30 years after his first works) and currently available in Holland: *The Anatomy, Bite and Effects of the Tarantula*[50] by Giorgio Baglivi (1668-1707).[51]

This work is published within *The Practice of Medicine*, a volume dedicated to a reform of medicine based on the synthesis of three elements: meticulous observation of the sick, experimentation and clinical definition of diseases. This research program benefits from the legacy of Hippocratic medicine, Baconian empiricism and the Italian iatromechanical tradition. Baglivi's dissertation on tarantulas is full of information on the spider, its places, the effects of its bite and musical therapy. Moreover, all this news were collected by an author who – Apulian of adoption – claimed a direct knowledge of facts, protagonists and places of tarantism. The study of the spider and its characteristics made use of direct observation, experimentation and comparison with the most up-to-date literature on the subject. In addition, the collected information was ordered with the solid criteria of natural history, prefigured by Bacon and adopted by the fellows of the Royal Society, of which Baglivi himself would later become a member.[52]

As far as colors in tarantism are concerned, Baglivi offered many indications. These informations – about the effects caused by tarantulas in northern Apulia, whose poison makes the victims feel attracted to colors like red, green, light blue and occasionally black – are mainly taken from Epifanio Ferdinando's *One hundred stories*. In Baglivi's opinion, if the victims of a tarantula's bite saw someone wearing clothes of the color they did not like, the aforementioned symptoms would worsen and they

[50] In Leiden, by initiative of the editor Frederik Haaring, the roman text of *De anatome, morsu et effectibus tarantulae* was published, in the work *De praxi medica*, in 1699, in 1700 and in 1704. See PENNUTO 2003, pp. 96-107.

[51] Baglivi was a very famous physician in his time. He was born in Ragusa (Dubrovnik) in 1668. Giorgio Baglivi lost both of his parents; so he and his brother Giacomo moved to Lecce (Apulia), where they were adopted by the physician Pietro Angelo Baglivi. Afterwards, Giorgio Baglivi studied medicine in Salerno, Padua and Bologna. Pupil and assistant of Marcello Malpighi (1628-1694), he became second physician of Pope Innocenzo XIII and then personal physician of Clemente XI. He was also Sapienza's professor of anatomy and later he became professor of theorethical medicine in the same institution. In 1698, he was elected a fellow of the Royal Society. He died in Rome in 1707. Baglivi's research focuses on two main themes. On one hand, the reform of the medical practice, according to a Hippocratic-Baconian orientation (*De praxi medica*, 1696); on the other, the definition of a solidistic and fibrillar physiopathology (*De fibra motrice et morbosa*, 1702). See GRMEK 1991; TOSCANO 2004; and TONETTI 2016.

[52] On Baglivi's natural history and his baconism, see CARLINO 2013, pp. 27-30

should escape from the view of said color in order to feel better.[53] According to Senguerd, instead, the thesis that those bitten averse certain colors has no evidence and is not reliable, so it cannot be accepted.[54] Baglivi's statements about colors are not based on an experimental criteria and so his arguments are not convincing. Nobody – Baglivi included – has ever documented a story similar to that of the Capuchin, reported by Kircher. It is a unique case and does not represent a universal law.[55] Therefore, this "occult" aspect of tarantism is denied in its empirical existence. According to Senguerd, there is no chromatic attraction towards the colors of the tarantula.

Conclusion

During almost the 50 years that separate the *Treatise* and the *Disquisition*, Senguerd had to deal with new natural history on the phenomenon, even though he tried not to be in contradiction with the first arguments about colors, such as those written by Baglivi which, at that time, were considered reliable with their direct observation of the phenomenon.[56] Even though in the *Disquisition* there are many passages quoted from the work *The anatomy*, Baglivi's name is never cited in Senguerd's book. Nevertheless Baglivi's work is used by Senguerd to strengthen his position with elements taken from a direct observation of the phenomenon, as it happens, for example, in the passage that describes the tarantula's birth,[57]

[53] See BAGLIVI 2015, p. 74: "De colore curiosa quoque observantur. Tarantati namque his coloribus delectantur, aliis contra graviter afficiuntur et pro vario depravationis phantasiae gradu alternatim variis rerum coloribus recreantur et affliguntur". See also FERDINANDO 1621, LXXXI, 2, p. 254b. On Ferdinando and Baglivi, see GENTILCORE 1999 and CARLINO 2015, p. 9-16.

[54] See SENGUERD 1715, p. 323: "quod nullo unquam argumento, vel experimento fuit evictum".

[55] See IBIDEM.

[56] See DI MITRI 2015, pp. 173-183.

[57] It is written in SENGUERD 1715, pp. 283-284: "Observatum, Tarantulam folliculum, congeriem ovulorum continentem, post partum amplecti, amplexumque per 12.15 aut 20 continuos dies continere; exinde in terra deponere, aestuique Solis, quo excludantur, committere"; while it is written in BAGLIVI 2015, p. 62: "Postquam peperit antedictum foliculum, arcte illum amplectitur, ut in figura tertia apparet, et ita amplexum per 12, 15 aut 20 continuos dies detinet et exinde in campis deserit, quousque demum ab ulteriori Solis actuatione maturata ovula excludantur".

or the music's effects on those who are bitten,[58] or also the characteristics of tarantulas that can be found in the mountains near Apulia.[59]

The choice of not mentioning neither Baglivi's name nor his *The anatomy* may be the result of several reasons; one may be connected to the fact that this work starts with a severe programmatic attack – repeated frequently throughout the text – towards those who are interested in tarantism but had never had direct experience of it. As a consequence, according to Baglivi, in all these authors' works (except for the work of Ferdinando) there is no valid contribution for an experimental explanation of tarantism, since they are all far from an empirical approach. In his opinion, the topic of tarantism was something yet unexplored and lacking convincing arguments.[60]

On the other hand, Senguerd, who had never observed tarantism and had become interested in the topic about 30 years before the publication of *The Anatomy, Bite and Effects of the Tarantula*, avoids citing explicitly a source, namely Baglivi, which could be problematic from a methodological point of view. In fact, it would have been contradictory to mention – as a trustworthy witness of tarantism – an author who considered unreliable all those who, before him, were interested in the matter but had no direct observation of it and did not study the topic with experimental methods.

The epistemic limits postulated by Baglivi – the belief that it is impossible to study this disease without observing it – presented a new challenge to Senguerd: to define himself as an expert of tarantism although he had not observed it directly. Although he didn't observe the phenomenon, as Baglivi argued to be necessary, Senguerd continued to study tarantism and reconstruct its natural history. In Senguerd's reflection, there is no preconceived opposition to Baglivi. After all, the authority of the physician was accredited in experimental contexts adjacent to

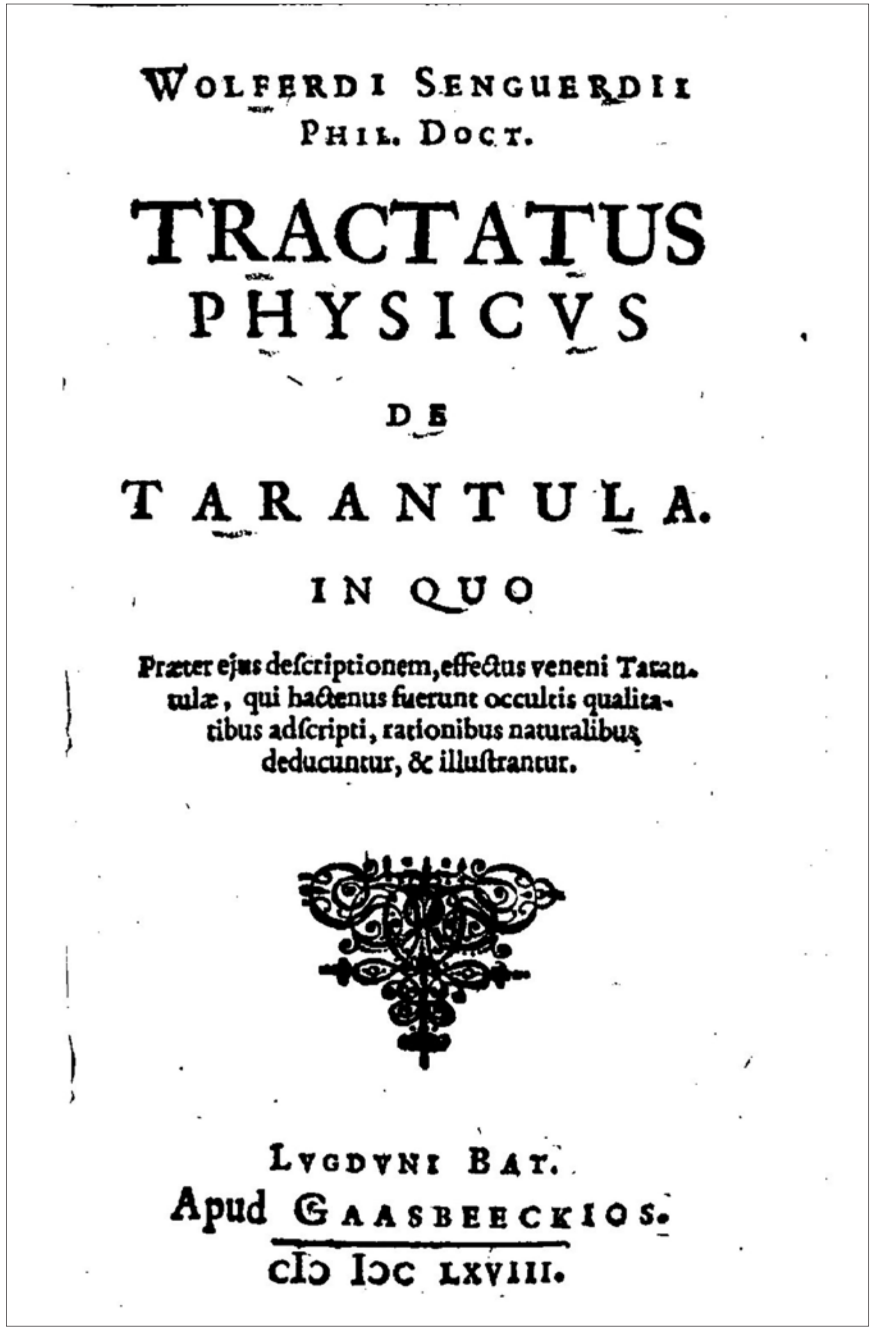
[58] On this point, SENGUERD 1715, p. 313 affirms that: "unde tarantiaci manus, pedes, aliqua membra segniter movere, ex lecto exsurgere, in pedes se erigere, in choreas dissolvi incipient"; while BAGLIVI 2015, p. 88 claims that: "sensim movere incipiunt manus, pedes et exinde reliqua membra, donec tandem in pedes erigantur, erecti ululant, suspirant, obscaena eventilant et saltationes integro triduo absolvunt".

[59] In SENGUERD 1715, p. 325, is cited that "in montibus Apuliae vicinis degentes, vel nullo, vel minime pernicioso pollent veneno", so similar to what was said by BAGLIVI 2015, p. 78: "nam quae in montibus Apuliae vicinis reperitur, vel nullo, vel non pernicioso pollet veneno".

[60] See IVI, pp. 46-48.

Senguerd as the Royal Society. This source allows Senguerd to update many points of his work, such as the description of the spider's anatomy, its properties and the effects of its bite. However, as we have seen in the case of colors, Wolferd does not hesitate to reject Baglivi's opinions, which are not the results of an experimental investigation and which seem to compromise his objective: clarifying the "occult" aspects of the disease. This new reconstruction of natural history, indebted to Baglivi, is functional to Senguerd's original and old purpose. This is an ambitious goal, which requires the use of several disciplines, from natural history to physics and medicine.

Fig. 13.1. *Portrait of Wolferd Senguerd*, Collection J.T. Bodel Nijenhuis, Leiden University Library, BN 1320.



WOLFERDI SENGUERDII
PHIL. DOCT.

TRACTATUS
PHYSICVS
DE
TARANTULA.
IN QUO

Præter ejus descriptionem, effectus veneni Tarantulæ, qui hactenus fuerunt occultis qualitatibus adscripti, rationibus naturalibus deducuntur, & illustrantur.

LVGDVNI BAT.
Apud GAASBEECKIOS.
CIↃ IↃC LXVIII.

Fig. 13.2. *Title page* of W. Senguerd, *Tractatus physicus de tarantula*, Leiden, apud Gaasbeeckios, 1668, p. 3 n.n.

Fig. 13.3. *Tarantulas* from W. Senguerd, *Tractatus physicus de tarantula*, Leiden, apud Gaasbeeckios, 1668, p. 1 n.n.

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Pierdaniele Giaretta*

CLASSIFICATIONS FROM AN EPISTEMOLOGICAL POINT OF VIEW WITH PARTICULAR ATTENTION TO THE CLASSIFICATIONS OF DISEASES

Is classification a kind of scientific production that is generally taken as a main topic in the history of science? Apparently not. The scientific developments that receive the most attention are paradigms—more or less in the Kuhnian meaning—and theories, observations, experiments, and technological innovations. Even from the epistemological point of view classifications do not seem to receive special attention, as it is generally believed that classifications, like textbooks, provide knowledge already acquired and, as such, might be useful for supporting research activity but are not particularly relevant in themselves.

Perhaps, this is a very simplistic assessment of the role of classifications. Some issues, such as the connection between classification and theory, deserve to be investigated. In particular, the case of the classifications of diseases seems to demonstrate that classification may play a role in helping to determine the identity of the classified entities and in highlighting the concepts that need to be clarified in this connection. As such, the classification of diseases looks as a relevant operation to outline medicine as a *scientia* or discipline of knowledge. Biological classifications, for which the notions of individual and species are fundamental, have or may have a similar role.[1]

In this brief reflection, I limit myself to considering, in addition to the general question of the relationship between classifications and theories

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[1] The literature about the biological notions of individual and species is extensive. The main references can be found in https://plato.stanford.edu/entries/biology-individual/#ProBioInd (by Robert A. Wilson and Matthew Barker) and in https://plato.stanford.edu/entries/species/ (by Marc Ereshefsky).

DOI 10.48255/M.9788891320186.14

and the multiplicity of possible classifications for the same collection of entities, the contribution of the nosological classifications towards the identification and distinction of the various diseases. I will conclude with an acknowledgement of the great variety of diseases and with an outline of some guidelines for a uniform and systematic management of this variety.

Classifications and theories

Sometimes it is said that some sciences are merely descriptive or classificatory, meaning that they provide descriptions and classifications without stating hypotheses. This opinion is not shared by Copi, Cohen and McMahon (2014):

> It is a mistake to suppose that hypotheses are important only in the advanced sciences, such as physics and chemistry, but play no role in the so-called descriptive sciences, such as botany or history. In fact, description itself is based on, or embodies, hypotheses. Hypotheses are as critical to the various systems of classification in biology as they are to interpretation in history, and as they are to all knowledge in the social sciences.[2]

So, at least for some sciences, classifications would depend on hypotheses. Copi, Cohen and McMahon (2014) also seem to suggest the possible dependence of hypotheses on classifications because, in the glossary, they expound the notion of classification in the following way:

> The organization and division of large collections of things into an ordered system of groups and subgroups, often used in the construction of scientific hypotheses.[3]

Thus, a classification provides a hypotheses-based description. Conversely, hypotheses can be formulated using a classification. Moreover, the hypotheses that are involved in exposing a classification or whose formulation refers to a classification can constitute a theory. Then we have two ways a classification can be connected with a theory.

[2] Copi et al. 2014, p. 575.
[3] Ivi, p. 576, 620.

Some scientists and philosophers of science have strongly emphasized the link of one type or the other between classification and theory.

Ernst Mayr (1904-2005), a well-known biologist, is specifically interested in biological classifications. He believes that a classification of a group of organisms based on evolution "has all the qualities of a scientific theory" and explains why:

> It has an 'explanatory' value, in that it designates the members of the *taxa* as derived from a common ancestor; a good classification has a high 'prediction' value regarding characters not studied in the past or to recently discovered species; finally, it has a 'heuristic' value, as it suggests previously neglected connections and generalizations.[4]

Mario Augusto Bunge (1919-2020), a physicist and philosopher of science, develops extensively the connection between theory and classification. He claims that both a theory depends on some form of classification and that classifications in turn depend on theories. In this regard, he specifically writes:

> Deep partitions call for hypotheses and, in particular, law statements, i.e. formulas about patterns. And, because law statements belong (by definition) to theories, if we want deep classifications we need theories, the deeper the better. Good examples of the power of theory to inspire deep classifications are contemporary biological systematics (based on the theory of evolution), the periodic table of the elements (based on the atomic theory), the classification of hadrons based on the quark model, and the classification of materials based on their constitutive relations or specific laws.[5]

Then he concludes by saying:

> Classing and theorizing are then mutually complementary activities. Categorizing precedes theorizing if only because every theory is about some category of objects. In turn, theory allows one to refine the coarse and shallow pretheoretical classifications. Moreover a classification *is* a

[4] Mayr 1998, p. 822.
[5] Bunge 1983, p. 330.

> theory of a kind. Indeed, unlike the propositions in a catalogue, those in a classification are logically related: they compose a system with logical unity. Thus from the statements that all mammals are vertebrates, and all vertebrates animals, it follows that all mammals are animals. To be sure this piece of knowledge is not a surprising new theorem but was available from the start, but the point is that it is a systemic proposition, not a stray one. Into a classification we pour all we know about certain kinds, and from it we expect no new knowledge.[6]

According to Bunge, a classification is a theory consisting of a finite number of statements. Indeed, this is not true if we intend for the logical consequences of the statements belonging to the classification to also be part of the theory. However, most likely, Bunge means that there are no (or very few) pieces of relevant information, not already presupposed, that can be obtained only from the statements of the classification. A classification does not usually include new knowledge but can suggest predictive hypotheses and, as such, can have heuristic value. Thus, according to Bunge, the theoretical value of a classification is limited, perhaps more limited than what Mayr seems to claim, but the fact remains that a classification has a theoretical value.

If the link between classification and theory is really so close that one can say that a classification is a theory, even if only within the limits indicated by Bunge, one might think that because, in principle, it makes sense to attribute truth or falsity to a theory, so we can also speak of a true or false classification.[7] Such a possibility seems to be clearly connected to a non-nominalist and non-instrumentalist conception of classifications. In order to be qualified as true or false, a classification must say something about the things that it classifies, regardless of the preferences or conveniences, more or less subjective, of those who make the classification. But if a nominalist and tinstrumentalist conception[8] is adopted, it turns out that:

[6] IBIDEM.

[7] Copi, Cohen, and McMahon say that "alternative schemes of classification are neither true nor false" (COPI ET AL. 2014, p. 577). This is not so obvious when taking into account the recognized connection between classifications and hypotheses or theories.

[8] Bunge only says "nominalist", but the reported thesis is more appropriately attributable to a view that is also instrumentalist.

> [T]he *fundamentum divisionis* of every classification is arbitrary, without a real counterpart: every classification is artificial, and so no classification is better than any other one.[9]

The discussion about the *fundamentum divisionis* is occasionally taken up. Recently it has been enriched and complicated with the formulation and defence of conceptions that pretend to be simultaneously realistic and pluralist, as they admit that different aspects of reality are caught by different classifications even if they can be inspired by interests and objectives of a pragmatic nature.[10]

In the following, the *fundamentum divisionis* issue will not be addressed directly or extensively. However, something useful to address this issue might be said by starting to deal, as in the next section, with the connected and preliminary question of the possibility of speaking about truth or falsity of a classification.

Classifications and truth

The possibility of qualifying a classification as true or false is a question that must be carefully examined after moving on from obvious observations. There is a trivial sense in which a classification can be wrong: the entity X is classified as A, but in reality, it is not A. In this case we are talking about classification as attributing an entity to a class of entities having a certain property, and it is obvious that the attribution could be incorrect.

Can a classification also be incorrect as way of organizing a collection of entities in classes and subclasses? Suppose that certain objects have been correctly attributed to the classes of the classification because they have the properties that characterize the classes to which they are attributed. Concerning the class attributions, more classifications of the same

[9] BUNGE 1983, p. 329.

[10] DUPRÉ 1993 holds that pluralism and realism about classifications are compatible. In substantial agreement with Birger Hjørland and against Eric Scerri, who defends the legitimacy of the issue of *the* nature of the matter, he expresses this position also in a very interesting discussion about the nature of the classification provided by the periodic table, in a forum on the philosophy of classification published in "Knowledge Organization", 38, 2011.

objects can all be correct, even if they correspond to different choices of classes. Would it still make sense to distinguish true classifications and false classifications? Making such a distinction would be tantamount to distinguishing between true and false choices, and clearly qualifying a choice as true or false is inappropriate.

A choice of classes can and must be evaluated from other points of view. First of all, let us note that the choice of the classes is not arbitrary, or at least not completely arbitrary, as it is usually required that the set of classes chosen meet certain requirements. Taking into account that the subdivision into classes is repeated in successive levels, a natural requirement is that the classes of each level constitute a partition, namely, that each object of the collection belongs to a single class of the level. Of course, multiple classifications of the same collection can satisfy this requirement, and it is clear that the mere satisfaction of this requirement does not allow one to speak of the true classification.

A classification is chosen in view of a goal. Does it depend on the nature of the goal if a classification can be called true? In particular, can it be said that qualifying a classification as true or false does make sense if the objective is cognitive, but it does not make sense if the objective is practical?

The question suggests an inappropriate use of the word "true", but above all, it is based on a distinction between the practical and the cognitive ends that requires a deeper exploration. By its nature, a classification has a cognitive aspect, even if the objective is practical. Copi, Cohen and McMahon (2014) mention that "primitive people needed to sort the poisonous from the edible"[11] and suggest that the goal of the sorting was practical. It was, but its achievement presupposed the correct attribution of the property of edibility. On the other hand, a goal can be purely cognitive in the sense of not being subordinated to a practical one. The very edibility of plant fruits can be pursued as a purely cognitive objective. Other objectives can also be the objects of purely cognitive attitude, like the shape of the leaves, the colour of the flowers, the height of plants, and so forth. In any case, because an epistemic aspect is involved even when the goal is practical, different classifications could be epistemically evaluated on the base of which and how much knowledge they presuppose and which and how much new knowledge they can promote.

[11] Copi et al. 2014, p. 576.

Let us idealize the notion of knowledge by supposing that knowledge is always knowledge of truths. Clearly, from this point of view, different amounts of (true) knowledge can found different classifications, and these, in turn, promote different corresponding amounts of new knowledge. Furthermore, one classification can be based on deeper and more extensive knowledge than that on which another classification is based. However, this does not allow us to qualify one as true and the other as false. It seems natural to say that both have to do with truth, and the different ways they deal with truth could be analysed and specified.

If we idealize knowledge in a different way by requiring, in a sense that must be defined, the proximity to the truth of the known propositions, we can make largely similar considerations. If, on the other hand, knowledge is conceived as completely detached from the truth so that the statements in which it is linguistically expressed cannot be evaluated as true or false, then one can doubt that one can speak of the foundation of the divisions of a classification. Perhaps, in such a case, we could only speak of subjective motivations of the divisions made, in connection with beliefs such that having them or not having them turns out to be more or less useful with respect to contextually determined purposes.

A classification can also raise the question of the *fundamentum divisionis* in a different way that does not presuppose – or, more likely, does not presuppose *only* – the reference to well-defined knowledge already available. So far, I have tacitly assumed that the entities to be classified are well determined and can be classified in different ways for different reasons. But there are also entities whose identity is uncertain, and this might even be a reason to doubt their existence.[12] A classification of such

[12] Typical is the case of diseases, which is discussed in the next section. The difficulty of identifying them can lead one to deny their existence and to maintain that only sick individuals do exist. Mirko Grmek, for example, considers diseases as models of reality and not as its constitutive elements. More than 250 years ago, François Boissier de Sauvages had already expressed himself in a similar way: "Genera and species of diseases are abstract notions; in fact, there are nor genera neither species in the world, but only individuals" (Sauvages 1768, p. 26). But Grmek sees a difference between diseases and biological species, as he says: "Diseases do not have the same ontological existence as living species because they are paradigmatic models of reality, not constitutive elements. Diseases do not exist in the same way as sick people, pathogenic germs or pathological processes" (Grmek 1998, p. 23). Claude Bernard is even more radical, as of the morbid entities and "creations" recognized by

entities is inevitably connected with the attempt to contribute to fix their identity, as can be shown by a brief review of some important classifications that have occurred in the history of medicine and which were much more than mere ordered lists of entities.

Indications from a very short history of the classifications of diseases

Let us remind that the formal aims of a classification are completeness (i.e., all the entities to be taken into account are included) and uniqueness of the assigned position at each level (i.e., no entity occurs more than once at each level). It is a common problem of many classifications that there are variants of the classified entities that are difficult to classify because they do not fit neatly into any of their types.

Classifying diseases presents some more specific problems. The disease of a particular individual should be seen as an instance of a type, which actually repeatedly occurs or can repeatedly occur. This is possible only if a disease is something unitary, but seeing a disease as something unitary is not so immediate: a disease, in fact, is made up of many different phenomena (body temperature, state of the skin, weight loss, pain, etc.) that are not necessarily connected in a single process. The identification of a disease is achieved through several steps that involve observations and decisions:

1. Some phenomena are taken into account.
2. Some of the phenomena taken into account are held as pertaining to a single disease.
3. Connections among the chosen phenomena are tentatively established.
4. A reason for constituting a single disease of the chosen phenomena is possibly provided, nowadays often by looking at something which is not directly or immediately observable.

Items 1–4 are not always chronologically successive stages. Some phenomena could be observed and taken as relevant at stages later than

most doctors, he says, in a paper published after his death, that "all this is just words" (Bernard 1987, p. 139).

1 and 2, and the investigations involved in 3 and 4 might be done in overlapping time periods. In other words, a disease is not a readymade object either a process easily and directly identifiable.

The uncertain, complex and various nature of diseases makes their classification difficult and variable.[13]

It is significant that different classifications of diseases have been tried and the more general and systematic trials conducted in relatively recent times. They started with the preliminary adoption of some general ideas or principles that should be applied in order to identify the diseases and carry on their classification.

François Boissier de Sauvages (1706-1767) claims to base his *Nosologia Methodica sistems Morborum Classes juxta Sydenhami mentem & Botanicorum ordinem* (1763) on the Sydenham's notion of disease as a natural particular process and on the application the method of Linnaeus' classification in *Systema naturae, sive tria regna naturae sistematice proposita per classes, ordines, genera et species* (1735).

Sauvages' general conception of a disease is substantially the same as what was expressed by Johann Georg Zimmermann in 1763: "We do not give the name of disease to every phenomenon of the body that moves away from the sound state, but to the confluence of those accidents [Züfalle], around which, by long observation, we know that they start together, grow, reach their maximum degree, decline and disappear together".[14] Accordingly, the basis for the definition of a disease is provided by a list of externally observable characteristics that are sufficient to recognize it and to distinguish it from other diseases. However, despite the proposal and the use of a *symptomatic definition* of disease, Sauvages clearly perceives the insufficiency of a purely phenomenological knowledge of the morbid phenomena because he defines nosology as "the science of diseases, or the aptitude to demonstrate whatever is affirmed or denied on diseases".[15] He argues that, in addition to the definitions of the diseases and their documented descriptions, nosology needs "certain principles, drawn from anatomical, chemical, hydraulic and mechanical

[13] Both aspects were highlighted in a smart, controversial manner in the case of syphilis by Ludwik Fleck in his *Enstehung und Entwicklung einer wissenschaftlichen Tatsache* (1935).

[14] Zimmermann 1763, p. 245.

[15] Sauvages 1768, p.11.

knowledge",[16] and he appears to aim at a philosophically founded nosology that will have the ability "to demonstrate what is asserted around the principles, the causes and the correlations of the diseases".[17] Therefore, the task of nosology would be a systematic presentation of what is characteristic of the various diseases, including the indications of their causes. We cannot say that this goal is achieved in Savauges' nosology, but it is methodologically significant that it was considered by him something to be pursued in the classification of diseases.

Clearly, a theoretical task is assigned to nosology, as understood by Sauvages. A more efficient and fruitful integration of theoretical approach and empirical observation is promoted by Giovanni Battista Morgagni (1682-1771), who in *De sedibus et causis morborum per anatomen indagatis* (1761) systematically pursues the goal of demonstrating how sets of symptoms correspond to sets of modifications of the normal anatomical structure. Fabio Zampieri fully and concisely expounds Morgagni's method for achieving this goal: "[T]he starting point was given by clinical data, the following step was the observation of what is remarkable on an anatomical-pathological level, in the end coming back, through an interpretation supported by a mechanistic model, to the clinical data, to justify their appearance".[18]

Even if it must be remarked that the clinical data collected by Morgagni are quite poor,[19] and his taking the organ alteration as the cause of the disease appears to be inappropriate as the very alteration of the organs needs to be explained, his method allowed and promoted the acquisition of a deeper knowledge of diseases.

Morgagni's approach is later further developed by Karl von Rokitansky (1804-1878) and Rudolf Virchow (1821-1902), as shown by their treaties, which are also classifications, respectively: the *Handbuch der pathologischen Anatomie* (1842) and the *Handbuch der speciellen Pathologie und Therapie* (1854). In these handbooks they based the classification of diseases on the parts of the body they affect. Von Rokitansky also believes that the pathological alterations of the solid structures

[16] Ibidem.

[17] Ivi, p.35.

[18] Zampieri 2016, p. 319.

[19] Vito Cagli notes that "as concerns the patient's physical examination, we are still far from something comparable to the precision with which the lesions in the corpse can be individuated" (Cagli 2015, p. 30).

of the organisms are the consequence of a generalized alteration of the blood, whereas Virchow claims that the pathological changes are nothing but cellular changes that are transmitted from one cell generation to the next. In light of these general theses, Virchow renews the whole pathology, introducing the systematic microscopic study of diseased tissues, thus giving rise to pathological histology. From the point of view of the general structure of the classification of diseases, the reference to the organ is still predominant. Conversely, the role of clinical data and their connection with the organ's lesion becomes secondary, especially in von Rokitanski's *Handbuch*. The connection between clinical data and anatomo-pathological data is again rather narrow in the *Lehrbuch der speciellen Pathologie und Therapie mit besonderer Rücksicht auf Physiologie und pathologische Anatomie* (1858) by Felix von Niemeyer (1820-1871).

In the second half of the 19th century, new discoveries had a strong impact on classifications of diseases. First of all, for some diseases, called "infectious diseases", unitary microbiological explanations were provided for both the clinical symptoms and the observed alterations of the body. Hence, in the *Lehrbuch der speciellen Pathologie und Therapie mit besonderer Berücksichtigung der Therapie* (1886) by Theodor von Jürgensen (1840-1907), a chapter was specifically dedicated to infectious diseases, grouped together because of the etiological role played by microorganisms. Cholera and tuberculosis were placed in this chapter, whereas they were previously catalogued among bowel diseases and chest (or other parts of the body) diseases, respectively.[20] Moreover, other kinds of diseases were identified for which the etio-pathogenesis was not so clear: metabolic diseases, concerning metabolism; endocrine diseases, related to a defect or an excess in some hormone secretion; and vitamin deficiency diseases, depending on the absence of some vitamin. The new discoveries produced corresponding extensions of and/or changes in the classifications of diseases. For the purposes of this work, it is not relevant to present these changes, but rather to observe the increasing difficulty of adopting a concept of disease that also provides a unique criterion by which to distinguish diseases. A grouping of diseases into a class and their distinction within the class may depend on a specif-

[20] This change in classification was noted by Cesare Scandellari. See Scandellari 2013, p. 94. In Scandellari's essay, a broader, more detailed presentation of the changes in disease classifications of the 19th century can also be found.

ic theory concerning a specific aspect of the constitution, structure or function of the human body. Thus, we have many theories that we can put together in different and somewhat arbitrary ways, because various theories, related to different independent phenomena, are independent. Correspondingly, we have different and partially arbitrary ways in which the various classes of diseases can be put together.

In sum, we have various theories for different classes of diseases, but no clearly preferable way of classifying all diseases. This applies to the nineteenth century and even to our day. A look at the *Harrison's Principles of Internal Medicine* (19th ed., 2016) shows that diseases are listed according a great variety of principles, and their order of presentation does not appear to be the only rationally possible.

Some suggestions about systematicity and value of classifications

Over time, disease identification has improved in conjunction with the expansion and refinement of disease classifications, apparently in a relationship of mutual dependency. It also seems that the increase of biomedical information, both clinical and pathological, and of theoretical explanatory power of the observed data has highlighted the large variety of the pathological phenomena and of their connections. The increase of this variety and of the difficulty of dominating it has brought out some characteristics that the classification of diseases has always had, to a greater or lesser extent: a partial arbitrariness, a difficult systematic organization and the not always negligible influence of pragmatic factors, such as the interest in developing a method of identification of diseases that is quick and, at the same time, useful from the therapeutic point of view.

Disease classifications today are less unitary, so to speak, since diseases cannot be distinguished on the basis of a single aspect, an affected organ or a pathogen or a functional anomaly or a genetic defect or something else. However, this does not mean that they cannot be well organized. The great multiplicity of diseases, both in number and in kind, makes a priori possible to classify them very differently. Perhaps it is not reasonable to look for one classification that is better than all the others. It is certainly reasonable and desirable to try to explain the way (or ways) in which classifications can be systematic, without pretending that the

pursuit of systematicity gives rise to a single classification. Systematicity and plurality are compatible. One could think, for example, of the elaboration of general classification schemes for the specification of a finite sequence of parameters on the basis of which to classify diseases. The parameters could be the origin (including possible genetic predisposition and the most relevant concurrent factors), the anatomical location, the mechanism of development, a list of effects on the organism, and so forth. The possibility should be acknowledged that some parameters are not specified, because they are not known; and therefore, in such a case, their relative place in the scheme would remain empty. Presumably, the number of possible classifications would still be very high, but some constraints or requirements can be formulated to identify the most useful ones from some point of view. Most likely, their formulation and choice according to the targeted objectives could be greatly facilitated through the use of computational tools. Of course, systematicity, even highly constrained systematicity, does not solve the problem of whether or not there is a more natural classification, or there are classifications more natural than others. The issue of the naturalness of a classification is a hard different problem, of strictly philosophical nature, that I did not intend to tackle.

Concerning the problem, initially addressed, of the relationship between theory and classification, it now seems quite clear that a classification, especially a classification of diseases, presupposes or incorporates important aspects of the theories accepted and may also depend on additional, though not necessarily explicit, hypotheses regarding the relationships between the classified entities. In any case it must be recognized that a classification responds, above all, to a need for organization of the knowledge that one already possesses. One can certainly ask, as Bunge does, if a given classification can contain something theoretically new and relevant with respect to the theory or theories on which it is based. The answer can be given only on a case-by-case basis, relative to the classification that is taken into account. In general, one can only state that a scientifically founded classification can conceivably have significant heuristic value for the discovery of new entities or the deepening of relations between classified entities.

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List of abstracts

Fabrizio Baldassarri & Fabio Zampieri, "Scientiae in the History of Medicine: an Introduction"

Abstract: In its history, medicine has undergone transformations through a combination of various, intersecting disciplines of knowledge, what early modern scholars called *scientiae*. Indeed, the early modern time appears to be one of the most thriving moments, and is probably the perfect period for exploring the active presence of these diverse disciplines at work. Since the sixteenth century, physicians benefitted from the creation of anatomical theaters as locations for the study of anatomy and for inspecting the human body more directly. At the same time, botanical gardens were built at universities as repositories of vegetal bodies (both medicinal and general plants) to be observed, studied, accommodated, and cultivated, while the construction of medical museums helped in shaping the discipline and favoured scholars in observing corpses and diseases, besides the mere instruction of non-experts. For example, the museums of anatomo-pathology at the University of Padua collects a case of the congenital condition *situs inversus*, that is, the reversed arrangement of visceral organs, making this peculiar case visible to scholars and learned people. In this sense, these locations represent both a historical venue, where one could explore the history of medical disciplines, and a place for current study and research. Understanding their construction and uses in the early modern time appears thus crucial to comprehending the boundless condition of medical knowledge and its changes and transformations at the beginning of the scientific revolution.

Fabio Zampieri, "The University of Padua Medical School from the Origins to the Early Modern Time: A Historical Overview"

Abstract: This chapter outlines the Medical School of Padua from its beginnings, especially shaping the interconnections and contexts that grounded the medical revolution of the sixteenth and seventeenth centuries. Particular attention is devoted to highly-significant moments in the story of Padua, namely Vesalius and Harvey. Yet, in this chapter, I put such moments in their context, revealing how much the medical revolutions developed out of an interconnection of studies. First, we have decided to delineate some of the crucial cultural

characteristics of Padua. We believe, for instance, that the pre-humanistic movement which born already in the 13th century might be fundamental for understanding the following development of the University. Then, we have focused our attention on two of the most famous figures of the Padua medical school, namely Andreas Vesalius and Hieronymus Fabricius ab Acquapendente. About Vesalius, we have tried to highlight his humanistic culture, perfectly in line with Padua environment, and his revolution based on a new conception of anatomy as the queen of natural sciences. About Fabricius, we have highlighted his new philosophical approach in anatomical studies, based on the study of Aristotle, as well as his new use of anatomical illustrations, giving also a brief description of how his achievements were fundamental for William Harvey's discovery of blood circulation. With that latter discovery, we might support that ancient science definitively declined, opening the way to modern medicine based on the anatomo-physiology of man for understanding and curing human disease.

Cynthia Klestinec, "The Anatomy Theater: Towards a Performative History"

Abstract: Inside the anatomy theaters of the early modern period, professors pursued many pedagogical goals, introducing students to the subject of anatomy, investigating a certain region or function, and so forth. But what difference did it make if the anatomy lesson was conducted in a theater rather than the back room of a pharmacy, in a hospital, or in the private chambers of a professor? While there are many historical changes to document in the study of anatomy and in the form and content of the anatomy demonstration, this essay argues that the anatomy theater played a significant regulatory role in the educational and cultural history of anatomy. Focusing on the University of Padua's theater, this essay develops the theme of regulation—in statutes and decrees as well as descriptions of particular demonstrations—in order to reconstruct the performative history of the theater.

Florike Egmond, "Sixteenth-Century University Gardens in a Medical and Botanical Context"

Abstract: In the middle of the sixteenth century, a young physician from the south of Germany undertook a long journey in order to improve his professional knowledge. During this medical peregrination that lasted some seven years (1548-1555), Lorenz Gryll (also Laurentius Gryllus, 1524?-1560) visited nearly the whole of Western Europe. His trip was funded by the extremely wealthy Fugger family, and one of its explicit purposes was that Gryll – after his return to Germany – would help improve the standards of medicine and medical teaching in his native region by introducing what he had learned in the core zones of medical innovation in Europe, that is Italy and France. Gryll's journey, which we can follow thanks to his own account, triggers the main themes in this contribution about university gardens, medicine and botany in the 16th century: how medicinal were these university gardens, and in which contexts can we study their functions and uses? This excursion ultimately reveals the multifunctional organization of university gardens that went beyond mere medical teaching and ultimately shaped early modern culture.

Alberto Zanatta, "The Origin and Development of Medical Museum Heritage in Padua"

Abstract: Although scientific museology developed in Padua from different sources and attention, medical museology has a precise path, and it is especially interesting in defining medicine as a disciple of knowing or *scientiae*. In this chapter, I analyse the history of medical museology in Padua, revealing how much the history of medicine plays a crucial role in the development of medicine as a science, and in highlighting the central role of Padua in the history of medical knowledge. Scientific museology started in Padua with the Museum of Natural Philosophy of Antonio Vallisneri (1661-1730). By the end of the Seventeenth century, he started to collect specimens and rare product of nature. The purpose of his museum was to instruct students and demonstrate what Vallisneri called "philosophical curiosity", a different concept from the 16th century Cabinet of curiosities. In 1756, Giovanni Battista Morgagni (1682-1771) develoved the Padua medical museology. He planned the creation of a museum of anatomical and pathological specimens. Regrettably, this project was never achieved. Luigi Calza (1736-1783) composed in the 1760s a series of anatomic models in wax and clay, used for Calza's practical teaching to the pupils. This collection composed the cabinets of obstetrics. These models represented the physiology and the pathology of the pregnancy, childbirth and breastfeeding. Reports claim of an "anatomical cabinet" developed in Padua from the early XIX century: Leopoldo Marcantonio Caldani (1725-1813), Francesco Luigi Fanzago (1764-1836) and Francesco Cortese (1802-1883) collected pathological specimens in different part of the university. The final passage from Cabinet collection to pathological Museum took place in the early 1870s, thanks to Lodovico Brunetti (1813-1899).

Roberta Ballestriero, "The Science and Ethics concerning the Legacy of Human Remains and Historical Collections: The Gordon Museum of Pathology in London"

Abstract: This chapter addresses the issue concerning the legacy of human remains as it affects historical collections and museums of pathology, mentioning the legal approach to the dead. The changes ethical norms have undergone in recent decades in storing and exhibiting human remains, revealing a new moral attitude towards the manipulation of them, will be analysed. The Gordon Museum of Pathology at King's College London, one of the largest pathology Museums in the world, will be presented as a case study to underline the educational value of antique and modern scientific collections. A series of pathologi-

cal paintings and the wax models of the first British anatomical ceroplastic artist who worked in the nineteenth century will be discussed in order to remind us of the importance of the history of medical knowledge that acquires particular significance nowadays to document ancient, new and emerging diseases.

R. Allen Shotwell, "Between Text and Practice: The Anatomical Injections of Berengario da Carpi"

Abstract*:* In 1521, the surgeon, Berengario da Carpi, published a commentary on a fourteenth-century anatomical text. In his commentary, Berengario made reference to injections that he made in the study of the kidney and of fetal urination. Berengario's work predates the standard account of the development of anatomical injections by nearly a century, and it is my goal to provide the context for them. I describe how the injection procedures can be linked to medical practices of the late fifteenth and early sixteenth centuries while the purpose to which Berengario put them arose from debated topics found in the anatomical texts he was consulting. Berengario's injections therefore demonstrate that medical scientiae in the early sixteenth century combined practical experience and bookish, theoretical knowledge.

Maria Kavvadia, "Sources and Resources of Court Medicine in Mid-Sixteenth Rome: Erudition as an Epistemological and Ethical Claim"

Abstract: In his medical book entitled *De arte gymnastica* (Venice, 1569), the humanist physician Girolamo Mercuriale of Forlì (1530-1606) noted that the human body is the focus of several arts and disciplines of knowledge. Mercuriale put together his *De arte gymnastica* during his residence in Rome (in the years 1562-1569), where he served as the personal physician of Cardinal Alessandro Farnese (1520-1589), one of the most powerful Churchmen and patrons at the time. The *De arte gymnastica* is a book of exceptional erudition that combines medical with broad philological, historical, and antiquarian learning in Mercuriale's endeavour to recover the Greco-Roman gymnastics as the true medical gymnastics. Mercuriale's erudition reflects the intellectual trends of the Roman *milieu* that combined, rather than divided, *scientiae*, while it emerges as an ethical stance and tool of criticism against aspects of medical learning and practice at the time.

Alessandra Celati, "The Experience of the Physician Girolamo Donzellini in the 1575 Venetian Plague: Between Scientia and Heterodoxy"

Abstract: This chapter deals with early modern medicine as a "*Scientia*" against the background of the reception and repression of the Protestant Reformation in Italy. In particular, it examines the 1575 Venetian plague, by taking into account the personal and scientific experience of the heterodox physician working in the Republic, Girolamo Donzellini, a medical doctor and humanist in the sixteenth-century *Respublica Medicorum.* During the pestilence, he was serving an Inquisition life sentence in prison. As a heterodox doctor, a prisoner and the author of a treatise on plague, he provides a good case-study. Thanks to the rare evidence provided by the minutes of Donzellini's fourth trial in 1575/1576, this article describes what a prisoner doctor's daily life was like in times of plague. Moreover it analyses the medical treatise that Donzellini wrote during his detention: the *Discorso Nobilissimo e Dottissimo Preservativo et Curativo della Peste.* By doing so this paper intends to provide fresh insights about the intersection among medical, religious and social aspects in the development of sixteenth-century *Scientia*.

Elisabeth Moreau, "Pestilence in Renaissance Platonic Medicine: From Astral Causation to Pharmacology and Treatment"

Abstract: Pestilential diseases formed a category of epidemic and often fatal diseases, whose outbreak, causes and treatment were challenging to explain in the Renaissance. In exploring this theme in sixteenth–century Galenic medicine, I examine the Platonic account of "occult" diseases and treatment that was proposed by the French physician Jean Fernel (1497–1558). While Fernel developed a philosophical explanation of pestilential diseases in *On the Hidden Causes of Things* (1548), he also suggested a therapeutic application in his *Pathologia* (1567), *Therapeutices* (1567) and posthumous *Consilia* (1582). By considering Fernel's synthesis of ancient, medieval and Renaissance medical approaches to plague and pestilence, this chapter traces his views on astral causation, poisonous seeds and the innate heat in relation to pathology, pharmacology and therapy.

Fabrizio Baldassarri, "Elements of Descartes' Medical *Scientia*: Books, Medical Schools, and Collaborations"

Abstract. In this chapter, I explore the sources and collaborators that assisted Descartes to shape his knowledge of medicine, a branch of his tree of philosophy. I highlight three aspects: (1.) a direct collaboration with Dutch scholars such as Plemp, Vorstius, and Regius, who helped Descartes acquire anatomical skills, or develop anatomical observations; (2.) the contacts with scholars and physicians working in Leiden; and (3.) the references to, and possible uses of, medical books. What permeates all these three areas is the underlying presence of the Medical School of Padua, where the large majority of these scholars had their training, and the connection he had with the Medical Faculty of Leiden. In sum, Descartes' medical knowledge emerged from a combination of personal reflections, anatomical observations, collaborations, and the contacts with institutions that grounded medicine as a modern *scientia*.

Luca Tonetti, "Testing Drugs in Giorgio Baglivi's Dissertation on Vesicants"

Abstract: Discussions on the medical use of vesicants—a remedy able to induce redness and blisters upon application to the skin—attracted the attention of early-modern physicians due to the severe side effects on the body. Helmontian physicians in particular claim that vesicants are always harmful and, therefore, must be prohibited. Giorgio Baglivi (1668-1707), however, believes that vesicants could be useful under certain conditions. His *De usu et abusu vesicantium* [On the use and misuse of vesicants] aims at analysing exactly the cases in which such an application is permitted, and the cases in which it is not, and to explain how this remedy works. For Baglivi experimentation on living animals by means of infusory surgery plays a pivotal role in testing the efficacy of drugs or trying and discovering new ones. In this paper, I will provide a short overview of this undeservedly neglected dissertation, by describing Baglivi's experiments on vesicants and their implications for his medical perspective.

Manuel De Carli, "Tracing Senguerd's Footprints: Sciences and Tarantism at Leiden Universtiy (1667-1715)"

Abstract: The present paper deals with the reflection on Apulian tarantism – the disease produced by tarantula's poison – of the Dutch philosopher Wolferd Senguerd (1646-1724). According to him, tarantism is a phenomenon which consists of many aspects explained previously throughout different traditional occult qualities; the various occult aspects of tarantism are clarified by Senguerd using several "scientiae", such as natural history, physics and medicine. Showing this particular view of tarantism, the first part of this paper is dedicated to the analysis of Wolferd's thought about tarantism and occult qualities, with particular reference to the analysis of the wondrous effects deriving from tarantula's poison. The second part focuses on how Senguerd used his source, namely Athanasius Kircher and Giorgio Baglivi, in order to prove that there is no chromatic attraction in those who are poisoned by the spider.

Pierdaniele Giaretta, "Classifications from an Epistemological Point of View with Particular Attention to the Classifications of Diseases"

Abstract. Classifications are connected with theories. The connection allows us to say that classifications have something to do with truth and knowledge. The kind of intended connection influences the way of conceiving the multiplicity of possible classifications for the same collection of entities. In some cases, a classification not only organizes the knowledge we already have of the classified entities but it helps to increase it. The aspect under which knowledge and classification interact most often concerns the identity of the classified entities. A brief survey of the classifications of diseases highlights this aspect. Moreover, it highlights the fact that different classes of diseases correspond to different theories, and that there is no clearly preferable way of classifying all diseases. Some ideas for a uniform and systematic management of this variety are proposed.

Printed in April 2021
by Grafiche Turato di Rubano (Pd)
on behalf of the Publisher «L'ERMA» di BRETSCHNEIDER